THE

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NOTICE OF REMOVAL.

THE "ELECTRICAL REVIEW."

THE "UNIVERSAL ELECTRICAL DIRECTORY."

The Offices of the above Publications have been removed to

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COMBINED SCHEMES OF LIGHTING AND TRACTION.

THE question of adopting some combined arrangement for supplying electricity for lighting, tramway, and other purposes from one centre, is probably the most prominent one before the electrical profession at the moment, and there can be little doubt that the contribution of Mr. Arthur Wright, which appears in another part of this paper, will be extremely helpful in placing the whole matter on a commercial basis.

We take it that electrical engineers are, as a rule, convinced of the utility of a combined scheme of lighting and traction, and it needs no special degree of wisdom to see that the development of electric tramways in this country will in a great measure depend upon the adoption of combination schemes. As a rule, Corporations already possess their own lighting works, and where they do not actually own the tramways, they usually possess powers of almost immediate purchase. When a municipality, therefore, embarks upon an undertaking which involves the supply of electricity and the running of electric tramways, it would savour of absurdity if no attempt were made to meet the demand for the two operations from one source. Although such a combined arrangement in its simplest aspect offers some alluring features, it is evident, upon the most perfunctory examination of the question, that it would be necessary to exercise great care to arrive at a proper adjustment of the varying conditions of lighting and tramway services. As Mr. Wright very pertinently remarks, the tramway department would have good ground of complaint if its receipts were bled for the benefit of electric lighting, nor could the users of electricity for lighting or other purposes be expected to rest satisfied that the tram fares should be cut down at their expense. To avoid future complications in the two operations, therefore it is highly necessary that some principles should be laid down as to the proper method of charging.

It is a little unfortunate that the question of combined schemes should have given rise, in one or two instances, to somewhat vexatious disputes. The case of the Bristol Tramways Company and the Bristol Corporation is still fresh in one's memory. The Tramways Company, with perhaps some reason, considered that they were to be the milch cow for the Corporation, and as they perceived no compensating advantages, objections were naturally raised. The state of affairs that has arisen at Glasgow has no parallel with what happened at Bristol. The Glasgow Corporation, which has been flirting with the tramway question for some years past, determined to work an experimental line on the overhead system, and authorised the Tramways Committee to lay down electrical plant for that purpose. It was not surprising to find the Electric Lighting Committee objecting to this course, and urging that the necessary supply of electricity to work the line should be obtained from them. Naturally the Lighting and Tramways Committees ap-

proach the question from totally different standpoints. They are desirous to do the best they can for their respective departments, and in their anxiety are apt to take a narrow departmental view of the matter. Had they been a combined committee, we do not for a moment think that there would have been any hesitation in adopting a scheme under which the new electric line obtained its supply of electricity from the existing system.

The question of what to charge for electricity for tramway purposes is not an easy one to determine, but generally speaking 3d. per unit, which is a figure that has fixed itself in the minds of many people, is much too high, and we cannot conceive of combined schemes making much progress under such conditions. One is apt to take an exaggerated view of what a unit of electricity can accomplish on a tramcar. We are told, as an average condition of things, that a unit of electricity will propel an average tramcar at an average speed for a mile. But a motorman, although his powers for evil may be limited by the series-parallel controller, can occasionally both destroy averages and dispel illusions. In two or three years time we shall no doubt have gained much experience from the results of working at Plymouth, Portsmouth, Halifax, and possibly other places, and no doubt these results will bring some adjustment of our ideas. As matters stand, however, at the moment, we are inclined to agree with Mr. Wright that an important point to remember in a combination scheme is, that both the electricity works and the tramway service should be undertakings that are separately self-supporting. If combined lighting and traction systems are to be successful, and we cannot reasonably conceive why they should not be, much will depend upon the application of a tariff on correct principles.

The demand for power on tramway services similar to those of Liverpool, Portsmouth, and other towns, must be very considerable, and it ought to be abundantly clear that if separate plant were to be put down quite distinct from the lighting stations, the actual motive power expenses would be very small. Figures from abroad may not reveal much, but it is interesting to observe that the power-house expenses on the Denver Consolidated Tramways stand at 1·094d., yet the total cost per car mile is over 6d. At Montreal, again, the cost of motive power is given at ·64d., but the total cost per car mile is 5·08d., power on the Halle Tramways costs ·766d. per car mile, and one might quote numerous figures which go to prove that the cost of power is one of the smallest items in tramway working. In estimating, therefore, the proper charge to make for a tramway system, it must not be forgotten that the chief expenses are incurred outside the generating station.

Secondary Batteries.

In the literature of the subject, especially in patent specifications, it has frequently been proposed to replace part of the lead peroxide in the positive plates by manganese peroxide. Thus, Heinze proposes to form the electrodes by the electrolysis of organic lead compounds in presence of manganese salts, stating that this increases the E.M.F. and prevents buckling. Fournier and Epstein specify an addition of manganese peroxide in forming the plates. The author shows by the following experiments that when manganese compounds are present in a lead accumulator (either as peroxide on the positive plates or dissolved in the electrolyte) they act as oxygen carriers from the positive to the negative plate; thus they tend to discharge the accumulator and diminish its capacity. (1) A freshly charged positive plate is placed in dilute sulphuric acid containing a little dissolved manganese sulphate. The characteristic colour of permanganic acid is exhibited in a few minutes, and the liquid shows plainly the absorption spectrum of this substance. The same reaction takes place slowly (12 to 24 hours) when the acid solution of manganese sulphate is simply shaken up with lead peroxide; it is much more rapid when the latter is in the form of a freshly charged plate. (2) A freshly charged positive plate containing some manganese peroxide is placed in dilute sulphuric acid; permanganic acid is again formed, and can be recognised by its colour and absorption spectrum. (3) Potassium permanganate is added to dilute sulphuric acid until the latter is distinctly coloured red. When a freshly formed negative plate of spongy lead is hung in the solution the colour gradually disappears. The spongy lead reduces the permanganic acid. A similar experiment can be performed with finely divided crystalline lead, prepared by electrolysis from lead acetate. As the permanganic acid is reduced, manganese sulphate is formed, and at the same time an equivalent quantity of lead oxide or sulphate. (4) From the above experiments it follows that when manganese peroxide is present on a positive plate (or manganese sulphate in solution) it is converted by the lead peroxide into permanganic acid; the latter is then reduced by the spongy lead plate, on which it sets free oxygen. Thus manganese compounds play the part of oxygen carriers in lead accumulators and diminish their capacity. If a charged accumulator containing such compounds be left to itself, it loses its charge with comparative rapidity; whereas a similar cell containing no manganese in the electrodes or electrolyte will, under similar circumstances, retain a considerable proportion of its charge. The above is an abstract by G. V. Knorre in the *Zeitschrift fur Elektrochemie*, 3, p. 362-364.

The Dielectric Constants of Frozen Electrolytes.

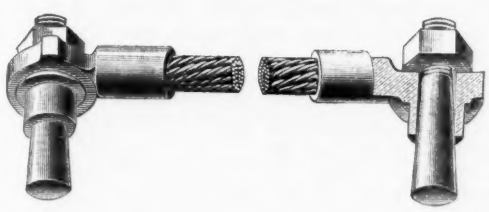
Early in the year Profs. J. Dewar and J. A. Fleming published a note in the *Proceedings* of the Royal Society, *vide* Vol. 61, on the dielectric constant of ice and alcohols at very low temperatures. In this study a number of difficulties were experienced which have since been eliminated, consequently a more careful study of the dielectric constants of various frozen electrolytes at and above the temperature of liquid air has been possible. The results of this investigation are given in the *Proceedings* of the Royal Society, Vol. 61, pages 300 to 316. Much of this paper is devoted to a minute description of the methods of procedure adopted, and to the tabulation of numerical results obtained with such substances as sulphate of copper, potassic cyanide, perchloride of iron, chloride of sodium, ammonium hydrate, dilute sulphuric and hydrochloric hydrates, &c. It will be sufficient to sum up the net result of this investigation as follows:—Frozen electrolytes at low temperatures are capable of acting as dielectrics, even in the case of those substances which in the liquid state and in aqueous solutions have relatively a very high electrolytic conductivity. At temperatures not far removed below their freezing points, these electrolytes have dielectric constants of large value, and numerically of the order of that ice or water at 0° C., or, in some cases, much larger. The majority of these high dielectric values so far as observed are reduced to a very much lower value (near to 3) when the dielectrics are cooled to and below the temperature of liquid air. Certain aqueous solutions of potash retain their high dielectric values to nearly the liquid air temperature, but give indication of being reduced at lower temperatures to small values. Frozen electrolytes at very low temperatures have very great insulating power, but recover sensible conductivity with great rapidity at temperatures far below their melting points. It appears probable that at the absolute zero of temperature all electrolytes become perfect non-conductors of electricity, or have infinite resistivity, also that it is possible their dielectric constants may all be reduced to, and represented by a number near to 2 or 3 at that temperature, that of a vacuum being taken as unity. Profs. Dewar and Fleming have been engaged in examining as many electrolytes as possible at low temperatures, in order to test the validity of the above last inference.

ELECTRIC CONDUIT TRACTION IN NEW YORK.

We boast of good solid and substantial road-bed construction in British tramway work, sparing nowadays neither trouble nor expense to get a track that shall stand with satisfaction the wear and tear of mechanical traction systems; but for absolute indifference to what the cost may be, English engineers may as well give in at once to their cousins across the Atlantic, for there probably has never been built such a heavy track under such onerous conditions as that now in hand for the Metropolitan Street Railway Company of New York over no less than 45 miles of their existing horse car and cable lines.

Prejudice against overhead wires in New York has for some time been strong enough to forbid any possible chance of installing the trolley, and therefore it became practically essential to put in a conduit road in the absence, at that time, of a proved alternative. Perhaps if the Aldridge system—which we described last week—had been introduced at an earlier date to the notice of the responsible authorities, it might have had a chance of proving its commercial value; but the conduit work is now well in hand on a very elaborate scale.

Apart from the track rails, which themselves weigh 107 lbs. per yard (being of a heavy girder type 9 inches high with wide shallow groove), the slot rails, yokes, conductor rails and other metal parts, weigh not less than 500 lbs. per yard in all, or a total of nearly 400 tons per mile. The entire



amount of metal required, apart from track rails, reaches nearly 18,000 tons, and the cost at ordinary rates must be at least £3,000 a mile of single track, not counting the line rails.

Of course some very heavy track and permanent way has been laid down in this country for cable working; but the conditions existing in New York are such as could hardly be found here. As an instance, we may cite the fact that for 300 yards or so the electric conduit tracks on one route have to follow the same street as that of a cable line now running. The tracks must be arranged with just space enough between centre to let the two conduits—cable and electric—be independent. This implies changing all the cable line yokes, which it is proposed to do without stopping the traffic.

The slot rails weigh 58 lbs. per yard each (it will be remembered that a centre slot is being employed for the New York lines, not a side slot, as at Buda Pesth; in fact, the idea has been, as far as possible, to design a conduit which might serve for cable working, should the use of electricity not give satisfaction), and the conductor rails each weigh 21 lbs. per yard. The latter are of plain T-shape, and are bonded by means of copper cable, on which copper studs are cast. The studs are drilled out hollow; the shank passes through a hole in the rail web, then a screwed taper bolt is put through the shank and drawn up tight, wedging the stud firmly into the rail. We illustrate the type of bond used in the annexed small engraving, for which we are indebted to the *Electrical World*.

Two conductor rails being installed in the conduit, there is no need for the track rails to form part of the return circuit. It is therefore largely a matter affecting the tramway company itself as to how much loss there may be in the conductors, consequently the situation of power houses, &c. Plant for operating the lower or downward part of the system is being installed in one of the cable power houses—a decided invasion of the enemy, according to some.

Four 800-kilowatt generators, direct coupled to horizontal Corliss engines, will drive this section; and three similar units will be added to the equipment at the up-town power house now used for working the Lennox Avenue and other conduit lines (hitherto looked on as experimental). A grand total of 7,000 H.P. will thus be provided for the group of lines now in hand.

Eventually a large station, about midway near the East River, will be built, and the entire system worked on the multiphase method of distribution to transforming stations.

Returning to the underground work, it may be of interest to note that the cast-iron yokes are set every 5 feet apart; every third yoke has a hand hole and weighs about 600 lbs. The intermediate yokes weigh 410 lbs. each. The track rail joints are made with no less than 12 bolts in two rows of 6 each, $1\frac{1}{8}$ inch bolts being used. The conduit shell is of cement concrete 4 inches thick, and a 6-inch layer of similar material is laid under the entire roadway.

It is not easy to imagine London streets given up to such work on the same scale; indeed, it is impossible, seeing that very few of our thoroughfares are wide enough to accommodate two tracks under simultaneous construction, and at the same time allow ordinary traffic. We rather doubt, moreover, whether the conditions of tramway work in this country are favourable enough to encourage such an expenditure of money, unless the local authorities do it themselves. Then, apparently, there is no limit to the amount that can be sunk.

BRITISH ASSOCIATION NOTES.

[FROM OUR SPECIAL CORRESPONDENT.]

SECTION A, AUGUST 25TH, 1897.

"On Zeeman's Discovery of the Effects of Magnetism on Spectral Lines." Prof. O. LODGE, F.R.S.

Prof. Zeeman's discovery of the widening and doubling of the lines, especially the D lines of the sodium spectrum, was explained, and the work of the author in verifying it and making it known in England was referred to. An effect of this kind had been looked for by Faraday, but without success, which indeed was impossible with the apparatus in use at that time. It had been predicted by Dr. Larnor, from considerations of mathematical analysis, which, however, indicated a displacement too minute for observation, and consequently no steps were taken by Dr. Larnor to have the question tested by experiment. The amount of the widening of each D line indicated by analysis was only about one-millionth part of that actually observed by Zeeman, and this discrepancy is still unexplained. The observation of the effect is rendered possible by the use of a Rowland's grating, and could not have been seen with the dispersion of a prism or train of prisms.

Prof. Lodge gave a general account of the considerations on which the widening effect had been predicted by Dr. Larnor. An electrified molecule moving in a curved path about a mean position, would experience an increase of centrifugal or centripetal force, due to a magnetic field perpendicular to its path, according to the sense of its motion, and its orbital period correspondingly increased or diminished. The diminution of the periods of some of the sodium molecules would tend to extend the spectral line in the direction of the blue end of the spectrum, and the increased periods of others to extend the spectral line in the direction of the red end. The whole effect would be to produce a widening of the line. This speculation does not account for the doubling of the line, while the size of the effect calculated is much smaller than that observed. At present Zeeman's observation is not satisfactorily explained by theory.

The next three papers were read by Prof. AYRTON, the joint authorship of himself and Mr. J. MATHER.

"On the Use of a Constant Total Current Shunt with Ballistic Galvanometers."

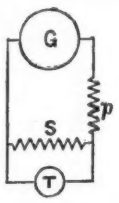
If T represent a source of electromotive force varying in

any way and having a resistance t; and G a circuit of inductive resistance g, and inductance L; S a non-inductive resistance $\frac{1}{n-1}t$: p a non-inductive resistance $\frac{n-1}{n}t$: then the law that determines the current in G is given by

$$v = n\left\{ l\frac{d\,c}{d\,t} + (t+g)\,c \right\}$$

showing that the insertion of the two resistances p, s, is a perfect shunt on the circuit G, of multiplying power n, for currents of any form.

Also the resistance of the complete circuit of G is unchanged by the insertion of these resistances, p, s, and the



law of decrement of the oscillations of a galvanometer placed at G is also unchanged.

The values of p, s, for any given value of n, are independent of G. The principle is applied to a ballistic galvanometer and trigger coil used for exploring magnetic fields, in which case T represents the trigger coil, and G the ballistic galvanometer. In illustration a suspended coil galvanometer was exhibited, in which a set of shunt coils was conveniently arranged round the instrument, constructed according to the principle explained.

"The Sensibility of Galvanometers," by the same authors.

This paper, consisting of a tabular statement of the constants and constructional details of a large number of galvanometers was not read, but some interesting figures were quoted from it. The most sensitive instrument that had come within the authors' knowledge was one that, with a period of 10 seconds, gave 90,000 scale divisions with 1 micro-ampere, the distance between the scale and the mirror being 2,000 scale divisions, and the resistance of the instrument 60 ohms. The most sensitive voltmeter tested had been recently constructed for use in the work of determining the true ohm by Lorenz's method carried out by Professors Ayrton and Viriamu Jones. It was a suspended coil galvanometer having a coil resistance of 1·9 ohms, amounting with the suspensions to 5·75 ohms. This gave 35·4 scale divisions with 1 microvolt, the scale being distant 2,000 scale divisions from the mirror. This was stated to be from 12 to 20 times as sensitive as the best patterns of such instruments in current use.

"Short *versus* Long Period Galvanometers for Very Sensitive Zero Tests," by the same authors.

This paper was not read, but Prof. Ayrton stated that they had arrived at the general conclusion that within wide limits there was little to choose between the two classes of instrument, as the sharply defined action of the short period instruments fairly counterbalanced their small sensibility.

THE RATING OF RESISTANCE SPIRALS.

By V. ZINGLER, A.I.E.E.

The construction of resistances is not a business for which any hard and fast rules can be laid down; there are almost as many different methods of building up frames as of firms who make them. Besides this, there are many types of frames for different purposes, such as for shunt regulating and breaking, arc lamps, motor starting and regulating, and other special forms for central station feeder regulating and accumulator work. Again, some firms box their resistances in with enamel and cast-iron, some lengthen, rather than increase the number of spirals, and some use patent alloys for which special advantages are claimed. It is, therefore, obvious that the number of combinations is too great to satisfactorily discuss or compare, much less to standardise in any way.

If we consider, however, only the question of spirals of wire, and those most commonly used, *i.e.*, platinoid and steel, it is possible, we find, to standardise these for a given quality or make, so that they may be stocked in long lengths. A series of tests having once been made, without a bridge, it then becomes no longer necessary to do any more than to call for a certain weight or length of spiral for any resistance frame, these properties being fixed by the watts required to be absorbed.

A Wheatstone's bridge is an expensive instrument to buy and when bought is often not understood or is misused; or perhaps the only man who knows how to use it is away.

The method of rating spirals of wire as herein given is no doubt not new, but is perhaps not known to many. It no longer becomes necessary to take a certain section of wire for your current, and measure off the ohms required by a bridge. This is an altogether erroneous method of proceeding, many other effects not being taken into account, as will be shown.

The first thing to do is to fix on convenient sized mandrils on which to wind the wire, and as some wires are thicker than others, the diameters of spirals herein referred to will be the *inside* diameters or the diameter of the mandrils. The diameters of spirals are more or less determined by the gauge of wire used. The next point is to decide on the best number of turns for a given length of spiral to which the wire should be stretched when under current, to obtain the best results; that is when the rigidity and watts absorbed per given length give the highest efficiency. For, of course, if the turns are close together, the watts absorbed will be greater than when the spiral is stretched out well, but there will be little radiation and little strength; on the other hand if the stretching is too great, there comes a point when the effective radiating surface ceases to increase and the watts absorbed get less and less. If such a table can then be obtained, the weight and length of spiral to absorb a given number of watts is at once apparent.

The tests required need not be scientifically accurate; indeed it is useless for practical work to attempt this. For instance, the gauges of wires supplied by two different makers are not always absolutely the same, although they should be, and hence a slight difference in resistance; not to speak of that found in different drawings of patent alloys, and especially of iron and steel. Even the wire-drawing has an effect on the resistance, if two similar wires are not drawn equally hard. We should not therefore attempt laboratory tests, for the resistances we require for practical working depend so much on outside effects that the error due to these will be much greater than that due to the aforementioned causes. It can therefore be assumed that for all practical purposes the spirals we standardise, made of material supplied successively by the same maker, will have the same average properties.

There are a great many points to be learned about a spiral before fixing it on the frame. Its principal requirements are (1) mechanical strength when fixed, to resist vibration or collapse, and to be able to hold up its own weight; and (2) physical qualifications to enable it to most efficiently absorb a certain number of watts without undue heating.

Owing to the reaction of these two requirements on each other, we must consider them together and not separately.

In constructing a resistance, it is usual to fix the spirals vertically, but occasionally it is necessary to place them horizontally. In the latter case they must of course be stretched out to a length sufficient to take up all sag. When placed vertically, however, the stretch must be such that the spiral does not bulge out or touch its neighbour when under current; that, if on a moving frame it does not vibrate, causing sparks by intermittent contact or gradually breaking off at the point of support; and also that the weight of the top convolutions does not cause those at the bottom to close up. In other words the spiral must be quite rigid and the distance between adjacent turns—or the pitch—must be equal throughout the length.

If we therefore take a convenient length, we can

standardise the spiral by the number of turns in this length giving the best results. Furthermore, although the spiral may give mechanical satisfaction when stretched cold, it may collapse as soon as current is passed through it. It is therefore necessary, when standardising the spiral to take into account the heating effect, which will of course depend on the number of watts per standard length which are absorbed. For convenience, let us take 12 inches as the standard length when stretched. We have next to deal with the diameters of spirals. These must of course depend on the gauges of wire employed, and to get the most practical results, it is best to assign to certain groups of gauges, certain diameters of mandrils. For instance, diameters of $\frac{3}{8}''$, $\frac{1}{2}''$, $\frac{3}{4}''$, and $\frac{7}{8}''$, are convenient, but of course this point is purely optional. The fact remains, however, that if a No. 19 wire is wound on a large mandril, say $\frac{7}{8}''$ diameter, its weight will be too great for it to support itself unless pulled out to such a length that it becomes inefficient—as explained before. Similarly, a No. 10 wire, if wound on a $\frac{1}{2}''$ mandril would lose its elasticity when stretched, and would take up a permanent set. There would be little radiation up the middle, and so we should get a small resistance without the maximum possible current.

The number of variables which we have to consider is therefore not small; these include gauge, diameter of spiral, number of turns per foot, watts absorbed, weight, &c. Their inter-relation would be too complicated for practice, and so it becomes better to fix certain sized diameters for spirals of certain gauges and observe the other points by actual experiment. In some experiments on platinoid wire tabulated, further on it was found that the gauges and mandrils could be conveniently arranged as follows:—

S.W.G. gauges.	Mandrils.
10, 11, 12	$\frac{7}{8}$-inch.
13, 14	$\frac{3}{4}$ and $\frac{5}{8}$-inch.
15, 16	$\frac{5}{8}$ and $\frac{1}{2}$-inch.
18, 19	$\frac{1}{2}$-inch.
19	$\frac{3}{8}$-inch.

If a certain number of these spirals are now made, they should be stretched between one fixed and one adjustable contact clamp, until for one foot stretched and with a certain arbitrary number of watts being absorbed—the spiral is just rigid. The current should be kept on for a minute or so, giving the wire time to heat up, and care should be taken that there are no draughts. The potential difference should then be observed between the terminals with a potentiometer, and the mean of the observations on the same type of spiral should be taken as correct. The standard for the watts absorbed must, of course, be dependent on the heat given out, and in these experiments the observations were taken when a strip of paper, held tightly round the spiral, just turned yellow.

Now, it must be borne in mind that the $c^2 r$ losses, or watts absorbed per foot of stretched spiral will not be proportional to the section of the wire, in the same way as if the wire were stretched out straight. Take, say, a $\frac{1}{8}$-inch diameter; as the section of the wire—or gauge—goes up, the rigidity of the spiral increases and so the spiral is not pulled out *proportionately* further. That is, the pitch of the efficient turns does not increase proportionately with the section of wire, but rather with the product of the section and number of turns per foot. We may then say that the $c^2 r$ losses are approximately the same over a *small range* of gauges for a given diameter of spiral, and this will actually be found to be the case in practice when using the charred paper test. The rough rule given above may be expressed as $c^2 r : a \times n$ where a = section of wire, and n = pitch of turns, or number per foot.

But the diameter of the spiral = d, is obviously proportional to a and also to n—at least we have made it so in the first instance. Therefore, we may roughly say that $d^2 : a \times n : c^2 r$—that is, that the watts absorbed are proportional to the diameter squared of the mandril, and this will also be found to be correct in practice.

The number of watts absorbed per foot of $\frac{7}{8}$-inch spiral stretched, when just charring paper, was found to be about 50, and thus by proportioning the squares of the diameters of the other mandrils, the watts work out to very nearly 50, 40, 30, and 20 per foot for $\frac{7}{8}$-inch, $\frac{3}{4}$-inch, $\frac{1}{2}$ and $\frac{3}{8}$-inch respectively.

The following tests, made on the above lines, are not to be taken for any other purpose than to illustrate the standardising explained above, and they, of course, apply only to the particular wire under test:—

Tests of Platinoid Spirals.

No.	S.W.G. gauge.	Dia.	Per foot.				Safe current.
			Turns.	Ohms.	P.D.	Watts.	
1	19	$\frac{3}{8}$ in.	96	1·48	5·45	20	3·67
2	19	$\frac{1}{4}$-in.	76	1·5	6·7	30	4·47
3	18	"	87	1·183	5·96	30	5·04
4	16	"	79	·693	4·56	30	6·58
5	15	"	101	·855	5·06	30	5·92
6	16	$\frac{3}{8}$-in.	54	·628	5·01	40	7·98
7	15	"	84	·865	5·88	40	6·80
8	14	"	71	·503	4·49	40	8·92
9	13	"	64	·331	3·65	40	10·95
10	14	$\frac{1}{8}$-in.	83	·684	5·85	50	8·55
11	13	"	53	·327	3·97	50	12·6
12	12	"	38	·186	3·05	50	16·4
13	11	"	38	·149	2·73	50	18·3
14	10	"	34	·121	2·45	50	20·3

Some of the observations in the table clearly demonstrate that there must be, for every spiral, a point at which its efficiency is greatest. Taking Observation No. 5, for instance, it is obvious that the number of terms is much too great, *i.e.*, the radiating surface is too small, and, therefore, although the watts are the same as the other spirals, the safe current instead of rising for a larger gauge, falls, and the spiral is also not so rigid as it should be.

Similarly Observation No. 6 shows that where the spiral is stretched to a point which happened to be beyond its elastic limit the resistance gets so small for the increased current that instead of using a No. 16 wire a No. 14 wire might have been employed to get the same resistance.

We can now turn to another form of resistance spiral. In cases where these are required for shunt breaking, motor starting and regulating, holophotes, electric cars and locos, slight changes in resistance due to heating are not important, and it is, therefore, usual to use iron or steel wire, because the metal is so much cheaper despite the proportionate reduction in resistance. Here, however, special attention has to be paid to vibration (as in moving resistances) and to collapse due to overheating (as in motor starting).

If spirals are suspended by their two ends on a moving vehicle, they are apt to vibrate and, perhaps, touch each other, causing sparking; the vibration also tends to break them off at the point of suspension. They are, therefore, now often wound inside and outside tubes lined with asbestos; the starting resistances being inside, and the regulating resistances outside, for better radiation. Starting resistances are frequently worked up to much higher current densities than regulating resistances, owing to the short period for which it is necessary for them to be in circuit. In standardising iron or steel spirals it is thus necessary to make tests for more than one current density, as with platinoid. The change of resistance due to heating is also useful to note, as the resistances can then be designed to be effective when a certain heat is evolved, or watts absorbed.

(*To be continued.*)

THE TELEGRAPHS OF THE UNITED KINGDOM.

By CHARLES BRIGHT, F.R.S.E.

(*Concluded from page* 328.)

III.—The State Era.

The Telegraph Act for the settlement of terms with the companies was passed in 1868. The following year the Telegraph Purchase and Regulations Act (for the administration of Government service) became law. Up to this time, our Government was the only one, besides that of the United

States, which had not undertaken the control of the country's system of telegraphs. When the transfer occurred, it was after 24 years' working by the companies.

On the Post Office actually taking over the lines in 1870, they at once established a universal rate for telegrams throughout the United Kingdom.* This was to be the same, whether by land wire or by cable, inclusive of Ireland, for instance.†

They started with a minimum (1s.) tariff for 20 words, the address eventually going free, and the charge for every additional word (beyond 20) being ½d.‡.

On this basis—which saved much trouble—the telegraphs were just beginning to yield a small return to the State, when the 6d. rate (minimum for 12 words, *inclusive* of the address) was introduced in 1885.§ Since then a heavy, but slowly decreasing, loss has been involved.

One of the first benefits of the change of management was the rapid extension of the system to small towns, and even outlying villages which, until then, had no telegraph.

Previous to the absorption by the State, the various companies, at any rate, the "Electric" and "Magnetic," had made their lines pay very well. Being in a fairly independent position—unlike a Government—they had been able to manage a varying tariff (by a system of zones) according to the distance.‖ However, the main point of difference was that they could consider whether a station at any given place would "pay," or not; and if the opening of such a station was pressed on them by the neighbouring inhabitants, they were in a position to insist on a subsidy, or guarantee, being granted.

The Government, on the other hand, have to take the telegraph into a large number of small villages, which often take a considerable time to pay the expenses incurred in the setting up of the line, station, instruments, &c.

According to the Postmaster-General's report, during the Post Office year, from April 1st, 1894, to March 31st, 1895, the number of inland messages which were transmitted was 58,907,408, placing the average value to the P.O. of an ordinary inland telegram at 7·66d. per telegram, and the number of press inland messages (at press rates) = 6,743,941. The foreign messages (from the United Kingdom to the Continent by Government cables) was 5,937,715, the total amounting to 71,589,064,¶ and the receipts to £2,241,254. A deficiency of £452,803 was thus involved by the Telegraph Department of the Post Office, as against a £477,327 deficiency of the previous year.

According to the last census (1894) the population of Great Britain and Ireland is about 38,900,000. This being so, by comparing the above figures with those of the total number of telegrams sent over the Government telegraph system, we arrive at the proportion of each inhabitant of the United Kingdom sending 1·8 messages during the year, supposing that everyone were in the habit of using the telegraph, and to an exactly equal extent.

To give an idea of the vast amount of work carried on at the Central Telegraph Office, London, it may be incidentally mentioned that recently the average number of messages (*exclusive* of news) which have passed through this office during the course of the day has ranged between 130,000 and 150,000, according to the season of the year, varying principally with the amount of business done.

Partly owing to a mistake in the drafting of the Telegraph Act of 1869, press messages go at a more reduced rate than was ever intended. Since the absorption by the State there has been, therefore, an immense increase in the press traffic.*

In fact, by including press work, over 600,000,000 words are despatched nowadays by the postal telegraphs in a year, or at the rate of about 2,000,000 a day.

Great advances in the working of the land telegraphs have, of course, been made within recent years—due both to the greater efficiency (higher working speed) secured with the instruments used as well as to the administrative ability exercised—largely resulting from experience.

It would be beyond the scope of these articles, however, to go into the working of these land telegraphs. It suffices to say, as an example of the high speed attained on the Post Office system of land telegraphs that as many as 600 words a minute can be transmitted with the "Wheatstone Automatic" on a circuit (principally used for press purposes) where such a high rate is desirable.†

Of late the iron wires of most of the longer overhead lines have been replaced by copper wires, which give a higher speed of working and permit of a smaller gauge being employed, thereby rendering them less subject to trouble in rough weather.

Within the past year or so many of the lightships and coastguard stations, hitherto isolated, have been connected with the main land system of telegraphs, for the better protection of life and property at sea, by affording a means of communication in time of need of succour or rescue.

In spite of continual improvements at great cost, there is good reason to hope that the postal telegraphs will soon begin to pay, and—like the post system—contribute their quota to the country's revenue.

The telephone commenced to come into use about 1880.‡ Various companies were then promoted in the United Kingdom for establishing telephony throughout towns, but in 1880 it was decided by a court of law that a telephone was practically a telegraph. From that date the telephones have been worked under a license from the Government. May be, before long, they will come within the entire control of the Post Office.

On the other hand, it will be obvious that this system of Government administration and monopoly could not nearly so readily be extended to the international submarine cable service.

* In 1855 the tariff of the various telegraph companies in the United Kingdom had varied from 1s. 6d. to 4s. a message, with the address free; and in 1865, from 1s. to 2s., though the charge for within the confines of certain towns was only 6d.

† Previously the companies had been in the habit of imposing an increased rate for telegrams to Ireland on account of being partly conveyed by cable. This varied in London from 3s. to 4s., according to the part of Ireland to be communicated with. Correspondingly, as a part of the Government telegraph system of to-day, it may be mentioned that the cost of telegraphing between England and France is at the rate of 2d. a word, with a minimum five-words charge.

‡ It was said that the universal tariff could only be put into effect in place of the zone tariff by the word system being at the same time adopted instead of the message system.

§ This came about mainly in response to a strong representation that the unit of charge—*i.e.*, the minimum tariff—for telegrams should be lower than 20 words. Previously, in 1861, the companies had adopted a 6d. rate for town service and between neighbouring towns. The "London District" Company had, indeed, worked about 100 stations entirely on the 6d. rate system.

‖ In the very first system of the Electric Telegraph Company, the tariff was mainly based on an estimate of the maximum figure which could be safely asked. As soon as competition had to be dealt with, in the shape of the "Magnetic" Company, some attempt in the direction of a zone system of tariff by distance was soon made. This culminated in 1s. for 100 miles, 1s. 6d. for 200, and 2s. for anything beyond that distance. A somewhat similar zone system was also the custom with the Government telegraphs in Belgium and Switzerland.

¶ The corresponding total number of messages over the entire telegraph systems in 1852 was 211,137.

A METHOD OF MEASURING THE COEFFICIENT OF SELF-INDUCTION OF A CONDUCTOR.

By LAWFORD H. FRY.

The following exceedingly simple method is due to Herr Thiermann, of the Hanover Polytechnikum, and has been used with very good results in the laboratory there.

As will be seen from the scheme of connections shown in fig. 1, very few instruments are required, and these of the simplest nature.

They are as follows:—A conductor, marked S in the figure, having approximately the same resistance as the conductor whose self-induction is to be measured, a ballistic galvanometer, G, an ammeter, A, a battery, B, a regulating rheostat, H, and a special key, K.

* Thus nearly 500,000 words were distributed to newspapers on the night of one of Mr. Gladstone's great political speeches.

† Particulars of the advances made in telegraphy in this country from year to year may be gleaned from the periodic lectures and papers of Mr. W. H. Preece. C.B., F.R.S. (engineer-in-chief to the Post Office) before the Society of Arts, British Association, &c.

‡ At the Paris Exhibition of 1881 the opera could be heard by telephone at the Exhibition buildings. This was thought a marvel at the time.

The conductor whose coefficient of self-induction is to be measured is marked R in fig. 1.

The key is also shown in elevation in fig. 2. It consists of a brass lever, 6, pivoted at the point, 10, and held between

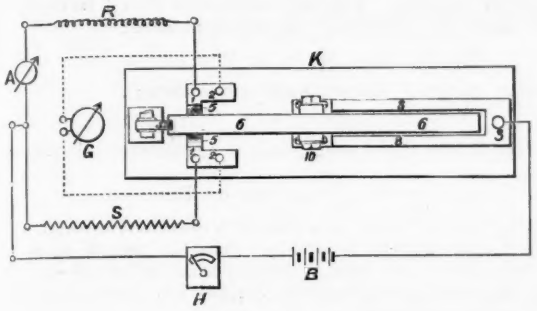


Fig. 1.

the two contact brushes, 5, by the trigger, 4. The spring, 9, tends to pull the lever out from between these contacts. The binding screws, 1 and 2, are connected with these brushes, and the screw, 3, is connected with the lever by the support, 11, and the strip of brass, 8.

In practice there should be a commutator between the conductors, R and S, and the binding screws, 1; but for the sake of clearness this has been omitted from the figure.

An examination of fig. 1 will show us that when the key is closed, the binding screws, 1, 1, will be of the same potential, being only separated by a few inches of thick metal, which is only carrying a small current. Hence though R and S are carrying current the galvanometer remains unaffected, but if the key be opened, R, S, and the galvanometer form a closed circuit.

To make a measurement, close the circuit and adjust the rheostat at H till the ammeter shows that there is an appropriate current flowing through R. Note this current. Then while watching the ballistic galvanometer pull back the trigger, 4. The lever flies up, opening the main circuit and breaking the direct connection between the contact brushes.

The E.M.F. induced in R by the disappearance of the main current is then free to drive a current through R, S, and the ballistic galvanometer.

The deflection thus produced measures the induced current.

Let c be main current in amperes.
c_s be induced „ „
e_s „ E.M.F.
r be resistance of R in ohms.
s „ S „
g „ galvanometer.
K be coefficent of self induction for R.

Then $e_s = K \cdot c$ for the main current varies from c to 0.
Also from Ohm's law—

$$e_s = c_s (r + s + g)$$
$$\therefore K \cdot c = c_s (r + s + g)$$
$$\therefore K = \frac{c_s}{c}(r + s + g).$$

The chief point to be aimed at in the construction of the key is to make the lever leave both brushes at the same moment.

The shaded portion, 7, in fig. 2 is a piece of insulating

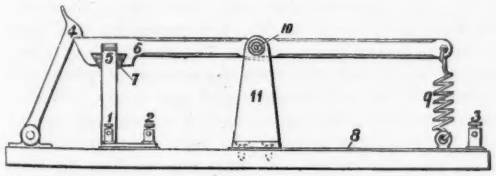


Fig. 2.

fibre let into the lever to prevent any twisting of the lever as it leaves the brushes.

The consequence of such a twist would be that the potential between the two brushes would be altered before the induced E.M.F. came into play.

A key, as described above, needs no particular refinements of workmanship, and could be constructed by almost any mechanic.

THE CENTRALISATION OF ELECTRICITY SUPPLY FOR LIGHTING, POWER, TRAMWAYS AND GENERAL PURPOSES.

By ARTHUR WRIGHT, Borough Electrical Engineer, Brighton.

The City of Glasgow is generally admitted to be one of the first, if not the premier city in the World in regard to excellence of municipal government, and it is not therefore surprising that the broad question concerning the proper form of administration and control for municipal electrical works, and the departments of public service now demanding electrical energy, should be first thoroughly ventilated there. While places of the order of Peterborough, Grantham, Newark, Retford, Doncaster, &c., are still disputing as to the economic possibility of electric lighting, our larger towns are rapidly coming to the conclusion that electricity is no longer "in its infancy," and that a little bassinette of a central station, on a site suitable for a small dry goods warehouse, is not enough to hold it.

The chief purposes for which energy is being supplied from electrical generating stations are private lighting, street lighting, motive power and tramways, and from the statement of Lord Provost Richmond at a recent meeting of the Glasgow City Council, it is clear that the necessity is now seriously felt of providing an organisation on an adequate scale, to deal with the important duties referred to. In the course of his remarks, the Lord Provost said that it was clear to him that the relations between the tramways and electricity enterprises of the Corporation required some readjustment, so as to bring them more into line, before either department entered upon any extensive scheme.

He thought that the time had come for an arrangement which would have the effect of consolidating and bringing into harmony the work of the two departments which could not, in his opinion, remain separate and independent of each other without friction and loss of efficiency on both sides. Both required to generate and distribute electric current, both required poles and certain fixtures, and both required underground conduits for their wires and other connections.

Assuming that the two enterprises continued separate and apart, and even setting aside for the moment the great question of producing electric current. Were they, he asked, to have one department putting up poles for lighting, and another putting up separate poles for tramway purposes, on the same line of street? In this connection, he believed, the lighting could be done effectively and artistically from the traction poles. Were they to have those two separate and independent departments cutting up their streets all over the city, to lay down and maintain each its own system of ducts, feeders, &c.?

The position they had arrived at was something like the following:—The Corporation were face to face with the necessity of providing in the near future 20,000 H.P. for the triple purpose of traction, power, and lighting, and the demand for current for all these purposes would probably continue to increase in a ratio much beyond what some of them imagined.

As a possible solution for this condition of things, he proposed to amalgamate the tramways and electricity departments. This done, they would, in his opinion, have laid the broad and solid foundation necessary for a thoroughly satisfactory scheme, which would secure in the future, unification of policy and administration, and the best economic results. The proposed coalition would not prejudicially affect one or other of the two departments as regards efficiency, economy, or harmony of working; and, on the other hand, it was certain to result in positive gain to both on all these points.

When they came to look closely at the two departments as they now stood, they found they were not so dissimilar as they might seem to the casual observer. They would require

the same motive power, and this of itself was a ruling point. Then, in the distribution of the current they could and should follow identical lines of street, and have, wherever possible, all their ducts for feeders, &c., in one and the same trench. This would save expense and a vast amount of inconvenience to the public caused by unnecessary opening and interference with the streets.

In describing the details of this scheme, the Lord Provost suggested the formation of what might be appropriately termed:

The Tramway and Electricity Committee,

this would form a chief committee which, for purposes of administration, would be suitably divided into four sub-committees, named respectively:

The Sub-Committee on Tramways.
The Sub-Committee on Electricity.
The Sub-Committee on Finance.
The Sub-Committee on Production.

The Committees would be assisted by officials selected for their competence in the respective departments, and the Chief Committee would, while guiding and reviewing the entire policy of the whole, retain the responsibility of fixing all charges for current supplied.

A full discussion on these proposals was taken at the meeting of the City Council on Thursday of last week, and while no final decision can be said to have been reached as to the precise arrrangement of committees, it is clearly the feeling of the great majority that the whole of the electrical energy for the requirements of the city should be provided from a common source.

A practical solution of the difficulty as to the arrangement of the committees may, I think, be found by simply regarding the departments of city work, such as the street lighting Watch Committee), market lighting (Markets Committee), pumping stations (Health Committee), and electrical traction (Tramways Committee), merely as so many customers for electrical energy.

In Ipswich, and some other seaport towns, electrolysed sea-water is now successfully used for sewage purification, and where this is done the Health Committee will become good customers for the electricity works. I merely allude to this latter as it is one example of the multifarious forms of user, of which the public generally are unaware, now maturing towards a demand for electricity. As another example, I may mention that the stations in London, New York, and elsewhere, are already doing a growing business in supplying electricity for charging electric cabs, omnibuses, &c. In the near future, it is probable that to these will be added motor dust carts, and fire engines.

I think it must be admitted that a committee entrusted with the highly responsible duty of furnishing electrical energy for the above purposes, and the perhaps more exacting private lighting, will be exceeding its functions in debating upon any details of the business of any of its customers, whether public or private.

Broadly, and from a municipal electricity supply point of view, it would be difficult to over estimate the importance of the discussion which has just been taken in Glasgow. It represents the serious endeavour of observant business men to forecast the electrical requirements of one of our largest cities, and by careful anticipation to save money and administrative troubles.

Perfection for the scheme put forward by the Lord Provost was explicitly disclaimed, and it was clearly the intention that it should be modified in any respect held to be expedient. As the policy eventually decided upon may be taken as a guide by other large towns, there need be little surprise if station engineers consider it rather seriously.

In such a form of model organisation I venture to suggest, for the reasons briefly expressed above, a somewhat different adjustment of the control. To adopt a title here which is conveniently descriptive, but would no doubt be shortened in practice, let us call the chief committee the

General Purposes Electricity Committee,

and entrust it with the sale of electrical energy for all the requirements of the district. The composition of such a committee by one member from each ward as proposed in Glasgow, would no doubt bring in gentlemen also serving on the several committees requiring electrical energy for the purposes of their respective departments, but it is not here suggested that this committee should directly interefere with their customers further than to see that their wants are properly supplied. This chief committee should be divided into three sub-committees respectively entitled:

The Sub-Committee on Production,

having charge of the works and sub-stations;

The Sub-Committee on Distribution,

having charge of the mains, feeders, connections and meters, and

The Sub-Committee on Finance,

having to do with all data, estimates, loans and accounts.

This arrangement is strictly within the natural lines of development of our present practice under which the staff of the largest central stations are divided into departments in the manner indicated.

The sub-committee on production should be responsible only for works' costs, regularity of supply, and the delivery of electrical energy into the mains at a proper pressure.

The sub-committee on distribution should be responsible for pushing the business, for laying out the system of mains to the best advantage, and for the organisation of the delivery to departments of the Corporation and private consumers in different parts of the district.

It would be for the sub-committee on finance to determine in regard to the supply of the tramways on the one hand, and the supply for lighting, power, &c., purposes on the other, the correct tariff based in each case on the amount of plant called into play at the works, the units taken from it, and the relation of the total distribution expenses to the two sets of mains, &c.

We need not now discuss the technical points which have been raised for and against the movement of local authorities in favour of centralising the generation of electrical energy so that lighting, motive power, and tramways shall have one common source of supply. In addition to Glasgow, several of the leading municipalities, such as Cardiff, Portsmouth, Plymouth, Halifax, &c., have determined to adopt this course, and arrangements have progressed so far in some of these cases, that shortly we shall have practical examples, the results from which will in due course enable us to form a fairly conclusive opinion. Certain economic and social considerations of some importance are, however, involved in this form of municipal centralisation, and it is such considerations that we may usefully discuss.

The supply of electrical energy to the public from electricity works has already been carried on for some 10 years or more, during which the different items of successive balance-sheets have been analysed and compared, so that to-day we have complete data, enabling us to see the exact incidence of the various expenses of production and of distribution.

The results of several undertakings have shown that the cost of providing and getting ready the necessary power plant at the works, whether it is for lighting, power, or tramways, is between 4d. and 5d. per day per maximum kilowatt demanded at the station, and the further works' cost of supplying into the mains the current required is between ½d. and ¾d. per unit, according to the local price of coal.

These are the expenses of production at the works, the remaining items come under the head of distribution. In the case of all customers for light and power, there are the expenses of the common network of mains to be taken into account, also the cost of house connections, meters, collection, &c.

In the cost of production and distribution, it does not matter what the product is for, the providing and getting ready for the power plant, mains, &c., entails fixed charges, the sum of which depends upon the amount of plant, mains, &c., having to be so provided and got ready. With the tramways, however, having a much less ramified system of feeders, less exactness necessary in regulation, no house connections, very few meters, and only one account to be collected, the distribution expenses are very much less than those incurred for the light and power users.

The most important fact brought out by the accountants has been that the cost of the raw materials, namely, coal, water, and sundry stores which are consumed in the manu-

facture, so to speak, of electricity forms, generally, a small item as compared with the administrative and other fixed charges.

The simple reason for this is, that it is not found commercially expedient to store electricity in large quantities, as is the case with gas; consequently an electricity works is in each department proportioned to the maximum demand made upon it by the consumers at the busiest hour in the year, for instance, on Christmas Eve.

Interest and sinking fund (generally the largest items in the cost of the unit), rent, rates and taxes, salaries, wages, &c., are all of them, in a greater or less degree, governed by this maximum demand.

For these reasons it is gradually becoming the standard practice throughout the country to make the tariff for the supply of electricity 6d. to 7d. per unit for the first hour or hour and a half's use of the consumer's maximum demand—thus first of all making sure of recovering from each consumer the bare cost of providing and getting ready plant, mains, &c., to supply him—then a very low rate about 1½d. to 2d. per unit for all the consumption beyond that.

It is found that such a tariff ensures an approximately equal rate of profit from all consumers, leads them to wire their premises throughout, and it has succeeded in encouraging a demand from those who can make use of current for many hours each day.

The above is the definition of a principle rather than the expression of an opinion, and although concisely expressed it clearly defines the terms upon which a tramway service should be supplied with energy from a "general purposes" electricity works.

We may take it that whatever the conditions as to ownership may be—whether the trams are run by the Corporation or a company—both the electricity works and the tramway service will be undertakings which *must be* separately self-supporting.

There are traces of an impression existing that when an electricity works supplies current to the municipal tramways, users of electricity for lighting and power purposes will *ipso facto* have a claim to substantial reduction in price. This of course is not business, the tramway department would have good ground of complaint on behalf of its passengers of every class, if its receipts were bled for the benefit of electric lighting. Nor, on the other hand, could the users of electricity for lighting or other purposes be expected to rest satisfied that the tram fares should be cut down at their expense.

It is true that all users of electricity benefit by deriving their supply from one common source, but the tariff applied to each class must surely be based on correct principles.

It is necessary then that the same general principles should govern the supply of electricity both for tramways, for street lighting, and for private purposes.

The first charge to the consumer, of whatever class, should include the proportion of standing charges proper to his maximum demand, all surplus being supplied at an agreed rate of profit upon the running expenses. This basis is an equitable one, and while it ensures that each class of demand shall be dealt with strictly upon its merits, it provides a check upon the maximum demand for the trams, which is very necessary for practical reasons with which we shall deal later.

In the case of an electricity works where the running expenses are just about ½d. per unit, and the tariff has been fixed at, say, 6d. per unit for the first hour and a half's use of the maximum demand, and 1d. per unit for all surplus, small private residences, which will ultimately become the backbone of the demand for lighting purposes, will pay an average price (being three-hour consumers) of 3½d. per unit, with participation, of course, in further reductions. It may be mentioned here that notwithstanding the high price of coal in Brighton (20s. per ton delivered), the average charge for electricity has, by the encouraging effects of the sliding scale, been brought down this year to a lower figure (*i.e.*, under 3½d. per unit) than obtains in any town where an all round price is charged.

It is now pretty generally taken as a truism that it is only by the operation of an equitable sliding scale that the infliction of unnecessarily high rates, such as 4d. per unit, upon hotels, small shopkeepers and private residences, for the benefit of early closing large shops and the like can be avoided.

In the case of the supply to the tramways, the fixed expenses on distribution account are relatively small, and it is not necessary that the same initial price should be charged. I am of opinion, instead of 6d., that about 5d. will be sufficient to cover, and that a subsequent rate of ⅝d. per unit, in a district where coal is cheap, would amply cover running costs, and leave a sufficient margin. The tram load is on for 15 hours daily, but the maximum amount of plant required for the service is probably not kept in demand for more than 10 hours per day. The resulting average rate would therefore be:—

$$\frac{(1\frac{1}{2}\text{ hours} \times 5\text{d.}) + (8\frac{1}{2}\text{ hours} \times \frac{5}{8}\text{d.})}{10\text{ hours.}}$$

or just about 1¼d. per unit.

A tramway which commences operations at 8 o'clock in the morning and continues until 11 at night is certainly one of the best customers that an electricity works could well have. With 30 cars *in running service* it would take the output of a 240 kilowatt plant, *but* it must be borne in mind that this 240 kilowatts will come on to the peak in the combined traction and general demand as the time elements must overlap in winter. Therefore, an additional amount of generating plant must be provided to the full extent named.

The total consumption would probably be:—

Cars.		Kilowatts per running car.		Days.		Hours.	
30	×	8	×	365	×	10	= 876,000 units.

and the yearly revenue would be:—

Kilowatts in maximum demand.		Days.		Hours.	Units.		
240	×	365	×	1½ =	131,400	at 5d. =	£2,737
					744,600	„ ⅝d. =	1,940
					876,000		£4 677

In considering the supply of electricity for general purposes, it is well to take a broad view of the prospects of development. It is quite easy to exaggerate the importance of the demand for traction purposes. Electricity works have been in operation for but a short time, and several of them, which have only been established for a very few years, are already supplying for lighting purposes a greater output than the tramways in their respective localities are ever likely to require. Even so, however, it cannot be said that they have made much impression yet upon the enormous demand for artificial lighting.

In the suburbs of all our provincial town there are rows upon rows of small private residences which are occupied all the year round, with the exception perhaps of two or three weeks in the summer time. They use as much light on Sundays as on week-days, and, unlike the shops, have no "early closing night."

This great field for electric lighting has hardly yet been touched, but the management of electricity works are now alive to its importance, and the effect of an average rate of about threepence, on the form of tariff referred to, will be to induce a consumption by these 3-hour consumers greatly exceeding that required for tramway purposes.

In this connection it may be mentioned that it is very probable that before the end of the present decade the consumption of electricity, even in a non-industrial town like Brighton, will be 40 units per annum per head of population.

The late closing shops in the side streets where the working classes do their shopping are also being recognised as a very important class to encourage.

In a town where there are tram-cars running, there is certain to be more horse-power required in motors for general industrial purposes than will ever be necessary to run the trams.

Some of the multifarious demands which are made upon electricity works represent influential classes in the community, and apart from general principles, it appears most desirable to frame a tariff which upon a common basis will afford the best terms to the best customers.

It is liable to be strongly felt by the ratepayer who uses his basement lights for 10 to 12 hours a day, or his motors for eight hours per day, that he should not be expected to yield a much greater *rate of profit* than the trams.

Dealing, now, with the practical point, to which allusion

has already been made. The invention of the series-parallel controller for the starting, stopping, and control of electric tram-cars has made it possible to run a tram service with little more than two-thirds the generating plant that was previously necessary.

The exact degree of saving in plant depends upon the expert care with which the cars are put into motion after each stoppage, and there are other means at the command of the tram department by which the maximum demand upon the electricity works can be kept within limits.

It has been shown that this maximum demand is one of the most important factors in determining whether the electricity works shall make a profit or a loss, so for this additional reason it is necessary to fix a tariff in which the responsibility of keeping its maximum demand in check shall be put upon the tram department.

The most convenient way in which to obtain the necessary data will probably be to place a watt-hour meter and an ordinary registering ammeter in circuit with each tramway feeder. The curves of the ammeters, when super-imposed, will show the incidence of the demand, while the sum of the meter readings will give the consumption.

In expressing the above consideration, I have endeavoured to impartially regard the well-being both of the tramways and of the electricity works, but it seems most desirable in the best interests of both departments, and the public alike, that financial relations should at the outset be established on an equitable basis, which will admit of accurate adjustment as time goes on.

CORRESPONDENCE.

Re Donaldson's Gas Engine.

My attention has been but yesterday drawn to an illustration and description of the above in your issue of the 3rd inst. And I beg to submit to you a few remarks, with tracings of engine and diagrams relating to the alleged wonderful improvement in the gas engine, wherewith the initial pressure of the explosion is to be raised from an ordinary 200 lbs. to something approaching 1,000 lbs. per square inch.

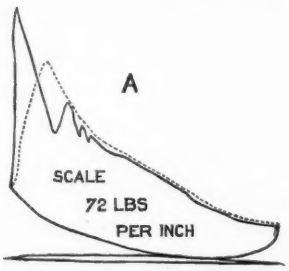
The exact value of expelling from the combustion chamber the residual gases after an explosion before drawing in a fresh charge, can be seen at a glance from the enclosed diagrams A and B. Of which A was taken by me from a gas engine and B from a light oil engine.

It will be noticed that the gain is greater in the oil engine than in the gas engine, and this is due to the lower compression and greater clearance area.

A more marked difference than shown in the diagrams, A, can be obtained in a gas engine working with either too much or too little gas feed.

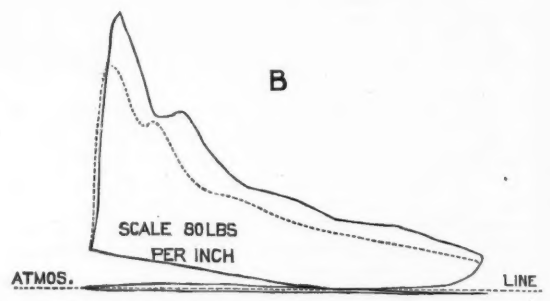
The higher the compression the less noticeable is the difference under ordinary conditions in the diagrams taken from an engine using town gas whether working with or without means for the complete expulsion of the residual gases.

Many attempts have been made to get rid of these gases in an engine working on the ordinary 4-stroke cycle; a few



Full line = Maximum diagram after scavenging charge of air.
Dotted line = Ordinary diagram after an explosion with residual gases left in cylinder.

Engine using Town Gas (cylinder 13" × 22", revs. 160) fitted with cam lift valves and tube ignition.



Full line = Maximum diagram after scavenging charge of air.
Dotted line = Ordinary diagram after an explosion with residual gases left in cylinder.

Engine using Benzoline (cylinder 6" × 11" stroke, revs. 220) fitted with ordinary lift valves.

devices similar to that proposed now to be used in the Donaldson engine were shortly as follows:—

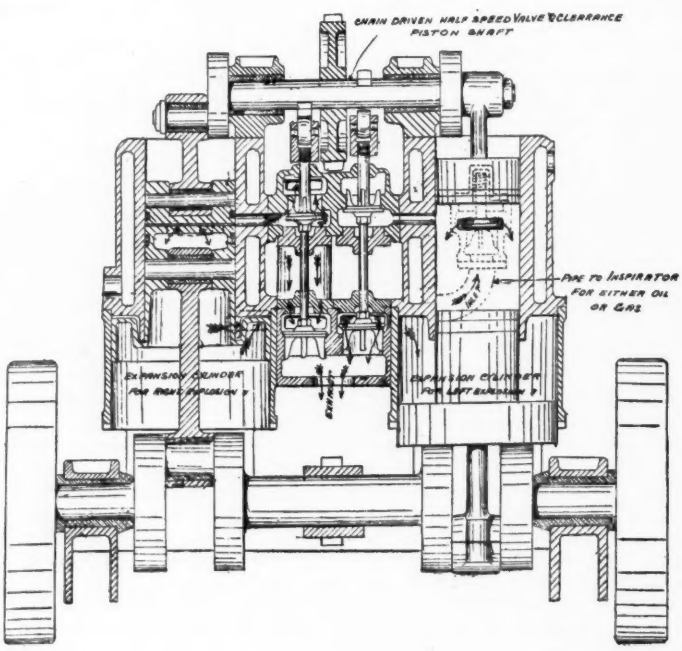
1st. A loose piston at the end of the cylinder adapted to be pressed forward to meet the power piston at the termination of the exhaust stroke, automatically by the recoil of a spring. (Southal—1885.)

2nd. Do. do. do., but adapted to be pressed forward by compressed air (Magee—1886.)

3rd. Do. do. do., but adapted to be pressed forward by a variable stroke lever actuated by a crank and rod on a half speed shaft. (Sterry—1887.)

4th. Do. do. do., the same as in the third instance, but with a cam substituted for the crank on the half speed shaft. (Hogg—1887.)

5th. Do. do. do., similar to No. 3, but in combination with a double cylinder compound engine, as per enclosed tracing.


CHAIN DRIVEN HALF SPEED VALVE
CLEARANCE
PISTON SHAFT
PIPE TO INSPIRATOR FOR EITHER OIL OR GAS
EXPANSION CYLINDER FOR RIGHT EXPLOSION
EXPANSION CYLINDER FOR LEFT EXPLOSION

The proposed method of compounding, as shown in the illustration of the Donaldson engine, viz., the combination of an expansion cylinder with a piston working on to a second

half speed shaft with one explosion cylinder with piston working on to a crank rotating two revolutions for each explosion was exactly anticipated in the "Acme" gas engine made several years ago, the identity to which many of your readers will recognise.

Edward Butler.

Gateshead, *September 15th*, 1897.

Kennedy's Multi-Circuit Dynamo.

Referring to a recent letter in the *Electrical Review* of New York on this subject, Mr. Rushmore who claims to have invented a multi-circuit dynamo, writes at considerable length extolling the advantages of this class of machine. I quite agree with all he claims for its advantages in some cases, but the fact that he has some in successful use and anticipates using a lot more of them has no bearing whatever on the question of priority of invention, nor does it prove that the multi-circuit dynamo has any advantages in the cases where he applies them.

In my original multi-circuit the circuits were independent and any one, or all of them, could be worked at any variations in load, and all the subsequent Patents for the multi-circuit claim this same feature, see Patents of Kingdon, Rothert, and Sayers.

In this country we have no Patent Examiners, hence Mr. Rushmore's 16 claims would not be objected to here, he would get his patent for what it is worth.

The question of the practicability of these dynamos is not at issue, but it is my opinion they have never had, and cannot have, a wide sphere of usefulness. I hope, nevertheless, that I may be mistaken, and that Mr. Rushmore will go on with his multi-circuits, make them commercially successful, and prosper in doing so.

Rankin Kennedy.

September 18th, 1897.

The Position of Motors for Electric Railroad Work.

In his letter upon the above subject, published in last week's Electrical Review, Mr. C. E. Grove has, I think (in his desire to come to a prompt and definite conclusion), taken the criticism of Mr. Baxter's article as being more decisive than was intended.

In these early days it is, perhaps, hardly wise to take any definite position upon electric railroad details until we have had more actual experience of thorough tests in ordinary working conditions. Otherwise there is a danger of having to "craw-fish" afterwards. We all admire decision of character, but perhaps it is best not to prophecy until one actually knows. By-and-bye we shall doubtless be able to judge with fairness the comparative merits of motor cars *v.* locomotives for electric railways. At present all one can do is to point out the advantages hitherto obtained on one side or other, though it is rather difficult to assign actual values to these advantages, and draw up a comparative balance-sheet.

With regard, however, to the chief objection that Mr. Grove raises to motor cars, I would point out that it is almost entirely met by the Sprague system of regulation described in last week's Electrical Review; whilst a somewhat pungent criticism of electric locomotives is afforded by a paragraph on page 370 (same issue), referring to a German electric locomotive which has to be weighted up by means of sand and ballast in boxes, in order to give a big draw bar pull without slip.

Mr. Grove will probably credit me with having made up my mind as definitely in favour of motor cars as he may have done for separate locomotives: but it is not so. I would only say that at present (and I wrote having knowledge of the Sprague regulation system) the advantages seem to lie on the side of the former; developments may arise at any time which would improve the status of electric locomotives.

I don't expect them, but would be the last man to say they *won't* come.

The Writer of the Article.

Contradiction.

It having come to our ears that a rumour is current that this firm is in liquidation, we should esteem it a favour if you will kindly give a contradiction in your next issue, and point out that we have no connection whatever with the late "Northern Electric Wire and Cable Manufacturing Company, Limited," Square Road, Halifax; the sole proprietors of our firm are Messrs. Frank and Riby Patchett, and the business will be carried on as heretofore at Sedburgh Mills, Halifax.

Per pro **The Northern Electric Wire Company,**
F. Mitchell.

September 18th.

Electricity Meter Tests.

There appears in a paper by Mr. Ricks read before the British Association at Toronto, a description of certain tests made in my laboratory on various electric supply meters. From the results there given it would appear that the Elihu Thomson energy meter (or so-called "recording watt meter") when used at ordinary temperatures reads about 13 per cent. too low at one-tenth full load, and that, when measuring ordinary direct current loads, an increase of temperature of 39° C. raises the speed of the meter by about 11 per cent.

I have no reason to doubt the accuracy of Mr. Ricks's results, indeed the very careful and painstaking way in which he carried out the investigation described in his paper leads me to think it highly probable that the figures and curves which he publishes do really record the behaviour of the meters which he tested. But, during my recent visits to the works of the General Electric Company at Schenectady, and at Lynn, I have become convinced that the particular meter which was lent Mr. Ricks by the British Thomson-Houston Company for testing can not be regarded as a sample of the instruments which are now being manufactured in large quantities there.

From his tests of the Thomson meter Mr. Ricks states it may, therefore, be surmised that the coefficient "of change of resistance with temperature of the pressure coil is very much less than that of the copper disc." To construct an energy meter with this difference in the temperature coefficients is, of course, quite wrong scientifically; and Prof. Elihu Thomson tells me that in his instructions he has emphasised the fact that the temperature coefficient of the pressure circuit should be equal to that of the copper pressure disc. As a proof that this condition is really fulfilled in the Thomson meters constructed in the States various curves have been shown me, from which it appears that, at ordinary loads, a change of 40° C. in the temperature of the meter alters the constant only 3½ per cent. instead of by the 11 per cent. found by Mr. Ricks.

Further, I have watched tests being made on one of these meters at Lynn at temperatures of 65° C. and at 24° C. The meter in question was a 50 volt 15 ampere meter, and, when tested at 52 volts and 11·75 amperes, that is at about three-quarters of full load, there was only 1 per cent. difference between the results obtained at these two temperatures although they differed by 41° C.

Next, as regards the difference between the value of the constant of this type of meter at low and high loads it would appear from the curves which have been shown me recording the results of various tests, that with some specimens there is practically no appreciable difference in the value of the constant anywhere between full load and one-twentieth full load, while with other specimens the constant is about 2 per cent. higher at one-tenth of full load than at full load. These are very different results from those obtained by Mr. Ricks with the meter lent him for testing, for he found that the constant at full load had to be increased by 19 per cent. to make the meter read correctly at twentieth of full load.

Some hurried tests at various loads were made in my presence here of the meter already referred to. The results at low loads were not very satisfactory as the meter armature turns very slowly, of course, at small loads; and time pressed as the factory was on the point of being closed for three days. Hence we had to content ourselves with timing one revolution only of the armature instead of waiting to take many, as was done in the very much more accurate tests carried out by Mr. Ricks. But it seemed clear that the

variation of the constant between full and *one-thirtieth* of full load was not as large as was found by Mr. Ricks between full and *one-twentieth* of full load.

Hence, I conclude, both from the curves of previous tests, as well as from the tests which I saw carried out, that the Elihu Thomson meter tested by Mr. Ricks had not merely a much higher temperature coefficient than meters constructed at Lynn, but possessed a greater frictional resistance, or had "an initial energy coil" which was not powerful enough.

W. E. Ayrton.

Lynn, Massachusetts,
September 6th, 1897.

The Troubles of an Infant.

A favourite expression of the platform or of the daily press is, or once was, "Electricity is in its infancy." Dare to use the expression now to an electrical engineer and he will do his best to show you that you are ignorant and unacquainted with the ways of electricity. You learn that electricity can do anything, and should you attempt to say anything on the question of motive power, either for stationary or locomotive purposes, you must needs possess a fair stock of the courage of your own convictions if you do not come away from the argument fully impressed that the only way of getting power out of coal is to burn the coal *somewhere* and use the power obtained therefrom through the agency of an electric motor *anywhere*. At least you must have electricity somewhere in the chain of transformations, and on no account must it be possible to use power in the room where it was first generated. It is extremely difficult for a common or garden engineer like myself to get definite information from men who have electrical machinery to sell. Suppose I want to blow an organ and I look up a catalogue. I there find that there is an arrangement of motor for doing this, and a self-acting device and regulating switch which "throws in resistance" as the bellows become full and finally stop the motor altogether. Only when the organist is approaching a climax and calling for a power of wind does the motor run at speed and use full current. Under light loads "resistance" is thrown in. One day lately I passed near a frame of coiled wires and was told it was a resistance frame. The current seems to me to heat up these wires and the more wires in series to be passed by the current the less current gets through. The editor will please say here if I am right in saying that the current heats up the wires. (Yes! Ed. E. R.). Is the answer yes? then am I not right in saying that the wires eat up the current? for heat cannot be generated except by the absorption of energy. This being so, it looks as though in order that the motor should do less work it must still use as much current. A steam engine parallel would be that to reduce the power of the engine a pipe should be taken from the steam chest and allowed to blow away to the atmosphere to waste. Now if this be the way to automatically regulate an electric motor, either the public are being gulled with wasteful machinery, wilfully so made, or electricity is in its infancy and electricians know no better.

Further, if I buy a steam engine and pay £40 for it, I expect to be able to buy a stop valve for such an engine for a few shillings. The valve and the engine have a certain ratio to one another, and if I can buy an engine for £50, I do not worry myself much about the stop valve. But this is not the case with electricity. My starting switch may cost me as much as the motor. If I want to start and stop a motor by automatic means—not to run it wastefully through any resistance, one man tells me I must occupy a few seconds in the operation, employing a resistance during this short time, and also having finally a sudden break to prevent arcing. Another man tells me I must simply use a sudden knock off and knock on, and the price for a very simple switch to do this will be nearly as much as the motor. I may pay £60 for the motor, then the switch will be £50 or in some such ratio. I receive two exactly opposite directions as to the method of procedure, and nothing to tell me why I should follow one or the other. Now I don't wish to say that my informants are not correct in their bare statements, but when a would-be-seller of electrical machinery *knows* that in my ignorance I hold the idea that a motor wants to be started by a slowly moved resistance switch, he ought not to make to me bold statements to the contrary and offer no explanation. I am not supposed to know anything of electrical working, and when I have to supply electrical machinery to customers, I want first of all to feel sure of my ground. An electrical motor seems to involve a good deal of making, and one can well understand that they cannot be sold for nothing or even at cheap rates. But there are so many and so costly accessories. I have already named the enormous expense of a "stop valve" for an electrical motor. Its supply "pipe" is fairly costly also, and there is an uncertainty generally about electrical work which is sufficient to make an ordinary contracting engineer hesitate before recommending his clients to adopt it. With the makers of steam engines there is no hesitation in affording a non-technical man all the information possible. With electrical machinery makers there seems to be a tendency towards withholding information, as though the giving of it might set up competing rivals. It may be that to electrical men everything is perfectly clear and straightforward, but I have my doubts, and I think very little is known of motors in this country, or why should it be so difficult to get definite information, and why are such simple matters as switches so very expensive? The mere materials are of small value, some copper alloy at a shilling a pound at most. Is it necessary that non-rubbing parts should be so highly finished, and is there any explanation as to the dearness of fittings? One hears a good deal of electrical work being cut so very fine, and yet if we begin to enquire for prices of things necessary to put in an electrical motor installation of a paltry three or four horse-power, we find prices are prohibitory; and I even found that when motors are put in the makers are unable to make them run in a satisfactory manner, and after all some other means has to be devised. Finally is there any published book of reasonable dimensions which explains to the practical engineer all that is necessary to know to enable him to scheme out an electrical drive and order his plant without further trouble? Why, in fact, cannot I myself turn to the catalogues of electrical manufacturers and buy what I want with the same ease as I buy steam engines? In the catalogue of a steam engine the size of the steam pipe is given. Is the cable size given in a motor catalogue? It is not. When you have got your steam engine, the steam pipe size is there to see without the catalogue, but the motor has no such size upon it. At most a motor is stamped with its voltage and amperage from which to calculate the cable size, as though a steam engine should be stamped with the boiler pressure as it ought to be.

Am I not then correct in still believing the electrical industry to be very much in the infantile stage?

A Millwright.

THE ENGINEERS' STRIKE.

The main point of interest since last week has centred in the proposals of Mr. Mather. Unfortunately Mr. Mather has exposed himself to a charge of grave inconsistency. Mr. Mather is said to have referred to the great help and assistance afforded to firms in the past, and yet one of his suggestions for the future is, that the employers shall grant the 48 hours' week on condition that they shall be free from restrictions and trammels in the future. Here are Mr. Mather's proposals as written by him:—

"That the Employers' Federation and Amalgamated Society of Engineers agree to meet and discuss the question of forming a working arrangement for the future, based on the following fundamental conditions:—

"1. That the working week shall consist of 48 hours, with a mutual agreement as to shifts, overtime, and other details, to meet special circumstances.

"2. That the question of the employment of machine tool and labour connected therewith, which has recently been the subject of discussion between the Employers' Federation and the Amalgamated Society of Engineers, and other questions not at present mutually agreed upon, shall be settled on such lines as the Employers' Federation shall be willing to accept.

"3. That on a settlement being arrived at, the Employers' Federation undertake to do nothing for the purpose of impairing the Trade Union, that no member of the Amalgamated Society of Engineers shall be treated with less consideration and respect than he received before the dispute, and that no member of the Amalgamated Society of Engineers shall be subject to exclusion from or disqualification for employment in any works of the members of the Employers' Federation, so long as the settlement exists."

If the 48 hours' week is possible, further writes Mr. Mather, it can only be so by the cordial and sincere co-operation of employers and

Trades' Union. But it is just this very thing which the Trades' Union will not grant. To them the employer is the enemy, and is spoken of as such. We know shops where the eight hours was granted, and since its granting, which was done without any demur on the strength of a statement that almost every other firm in London had joined, the amount of work done per hour fell off most deplorably. The complaint all round is that the men will not work. Their presence in the workshop is a mere farce, and they do not hesitate to declare that they will do just so much, or as little, as they please. Expostulation is vain, and appeal to the A.S.E. would be equally useless. Mr. Mather's opinions are, of course, entitled to some weight, seeing that as a large employer he has worked for five years on the eight hours' system; but let us ask Mr. Mather if the A.S.E. leave him alone in respect of the harassments to which other firms are subject, and if they do, why do they so, unless it is that his works have been singled out as a shop where the eight hours must be made a success by the men so as to pave the way for a general eight hours, which when granted will be the signal to let the Salford shop be harassed with the rest.

Mr. Mather says he was first on the field with eight hours. He has had now five years to pick his men. Undoubtedly, with an eight hours' day shop, the sober and steady man will try to enter such a shop. Messrs. Mather & Platt have got their pick of men, and at the same time the men can be kept hard at it all day. But were the short day general, it would be out of the power of this one shop to pick and choose as they like. They would have to take the "run of the mine," and eight hours would tell a different tale. Here is what the *Shipping World* has to say:—"A more frank avowal of the causes of the conflict on the part of employers and employed would have been more satisfactory to the public, which is deeply interested. Why can it not be clearly stated, on the part of the engineers, (*a*) that, whereas the strike for the eight hours' day was commenced on the Thames, success in that district would at the right moment be followed by a struggle in other sections of the country; and (*b*) that while they do not now raise the question of the status of men in control of one or more tools (machines), they maintain the right to do so at some future time. On the other hand, it would have cleared the atmosphere had the Federated employers declared (*a*) that, while they are opposed to the shortening of hours, they are prepared to discuss it, and endeavour to find a way out; and (*b*) that under no considerations whatever will they consent to less than a controlling voice in all that pertain to machines, and who shall work them."

It seems to us the Employers' Federation have very clearly made it known that they will be masters in their own shops, instead of, as now, being simply allowed to pay wages; for that is what matters have now come to, and no matter of doubt can remain that the Federation intend to be masters in their own shops. It is lunacy to think that trade can go on long upon other terms.

Mr. Jeans, in the *Engineering Magazine*, deals with the question. He states that the various Trades Unions in the country do not embrace more than a fourth of the possible members in the country, so that when Trades Unions strike a blow there are three-fold the number of free and independent workers to take their places, and the non-union men are better men and more self-reliant.

Mr. Jeans makes the statement that while Unions keep insisting on shorter hours and higher wages, they also demand the abolition of piecework and limit apprentices, while also forbidding a man to do more than they reasonably can do. The American who thinks himself a mighty clever and quick workman, does so because he measures himself against the wilfully slow unionist of this side. But the unionist who goes over there soon gets to do more than the native American.

Again, to refer to Mr. Jeans, he declares that the rules of the A.S.E. are not merely tyrannical as to the employer, but also in respect of their own members.

As to piecework, the late Mr. Mundella showed that 90 per cent. of our exports were made by piecework. How, then, can the Trades Unions reasonably object to it. He calls attention, too, to the condemnation of overtime by the Union, and to the fact that the Union men all seek to work in overtime shops. In this respect, we understand that it is most difficult to abolish overtime. The men will scheme and idle and shirk in order to compel overtime. Generally, the spirit of Trades Unionism is to discourage all individual effort or exceptional skill, and no specially good man can reap a reward for his better than average ability unless he leave the Union.

We note that Mr. Jeans is of opinion that the American workman is not so well off as his English *confrère*, but has to render more for his money. He also considers that no country has suffered so much from industrial conflicts as England. At the same time he attributes this to England's priority as a manufacturing country, with the inference that the near future may see the same troubles in America, though at the same time it may be that whatever results in England will become accepted facts elsewhere. The experiments have been tried here, and we have had to suffer for them. There is nothing even to show that this present struggle will be the last. The temper of the men points to it being but a mild precursor of far worse in the future; that of the employers seems to indicate that they have had their fill, and may as well die fighting as allow themselves to be shot with their hands tied.

Copper.—An engineering contemporary says it is announced by the Electrical Copper Company that a portion of the works established by them at Widnes to prove the commercial value of the patent owned by the company has been put into successful operation.

BUSINESS NOTICES, &c.

Electrical Wares Exported.

Week Ending Sept. 21st, 1896.	£	s.
Amsterdam	75	0
Borkum. Teleg. cable.	4,818	0
Boulogne	41	0
Brisbane. Teleg. mat. ...	763	0
Buenos Ayres. Teleg. wire	829	0
Calcutta...	139	0
Cape Town	490	0
Colombo	21	0
Durban	11	0
" Teleg. mat.	172	0
East London	738	0
Flushing	6	0
Gibraltar	15	0
Lisbon. Teleg. mat. ...	112	0
Madras	161	0
Malmo. Teleg. mat. ...	21	0
Mauritius	29	0
Melbourne	846	0
Nelson. Teleg. mat. ...	15	0
Passages	49	0
Port Elizabeth	93	0
Port Said	63	0
Rotterdam	28	0
St. Petersburg	88	0
San Sebastian	33	0
Shanghai	213	0
Singapore	9	0
" Teleg. mat. ...	75	0
Stockholm	339	0
Sydney	1,350	0
" Teleg. mat.	45	0
Tientsin	45	0
Wellington	1,115	0
Yokohama	8	0
Total	£12,855	0

Week Ending Sept. 21st, 1897.	£	s.
Alexandria	22	0
" Teleg. mat. ...	13	0
Amsterdam	95	0
Bangkok	110	0
Beira	300	0
Bombay	126	0
Buenos Ayres	224	0
Calcutta	353	0
Cape Town	162	0
Cologne	42	0
Colombo...	620	0
Durban	2,025	0
Lisbon	76	0
Malaga	20	0
Melbourne	85	0
Port Elizabeth	878	0
Rotterdam	56	0
Singapore	50	0
Stockholm	530	0
Sydney	685	0
Wellington	102	0
Total	£6,584	0

Foreign Goods Transhipped.

	£	s.
Boston. Teleg. mat. ...	278	0
Hong Kong. Teleg. mat.	82	0
Singapore. Teleg. mat.	50	0
Stockholm. Teleph. mat.	35	0
Total ...	£445	0

	£	s.
Perth	100	0
Total	£100	0

Accumulator Accessories.—Messrs. James Carter and Son, of Stalybridge, are making some improved forms (Highfield's patent) of bolts, connecting sockets, and washers for use on electrical storage batteries. It is sometimes found that after a battery has been in work a short time many of the connections from one cell to the next, and especially those lugs to which cables are attached, get hot when any considerable current is going into or being taken from the battery. This heat is due to the conductivity of the joint being reduced by acid vapour working in between the lugs and the nuts on the bolts used to connect them together, causing a deposit of lead and copper salts on the surfaces. A considerable loss of energy is the result, and occasionally, if neglected, the heat melts the lug. Messrs. Carter & Son are making some bolts and sockets with flanges on which are turned several concentric ridges, the ridged flange taking the place of an ordinary washer. When the nut is screwed home on to the lead lug, these ridges not only clean the face in cutting their way in, but also make a close air-tight joint, which entirely prevents acid vapour or damp getting in and corroding the surfaces, the result being, it is claimed, that the lugs do not heat, and all trouble on the score of dirty connections is saved. The sockets are preferably clamped between two lugs, the ridges acting in the same way. For large currents, double-ridged washers may be clamped between the lugs, thereby preserving the inner surface joint as well as the outer. For the attachment of flat bars or rods, single-ridged washers are used; they are sweated on to the bar, and then the whole is bolted home on to the lead lug as before. Messrs. Carter also manufacture an improved sight drop lubricator for high speed bearings.

A Fittings Ring.—An association has been formed called the China Furniture and Electrical Fittings Manufacturer's Association, the members of which are circularising to the effect that they are willing to grant to their customers who purchase from them china furniture or electrical fittings, certain advantages and concessions on condition that they bind themselves to confine their purchases of these articles only to the members of the Association, whose names are given in the circular. The secretary is Mr. W. A. Addinsell, 112, Edmund Street, Birmingham.

Award.—Messrs. J. C. Lyell & Co., of Victoria Street, have secured the gold medal and highest award for their Svea glow lamps at the Stockholm Exhibition. We understand they are now prepared to supply these lamps for all voltages, from 25 to 230.

Change of Address.—The City offices of Messrs. J. and H. Gwynne, Limited, have been removed to 64, Cannon Street, E.C.

Catalogues.—A new illustrated price list of dynamos and motors for continuous currents has been published by the Phœnix Dynamo Company, of Bradford. In addition to particulars of dynamos and motors, there is a price list of the firm's new enclosed motors, and specifications and prices for standard equipments for electrical cranes. Mr. Claude W. Hill, the firm's manager and engineer, has compiled the list, and has included some useful notes for electrical engineers when designing power and lighting plants. These, we understand, are taken from Mr. Hill's own books.

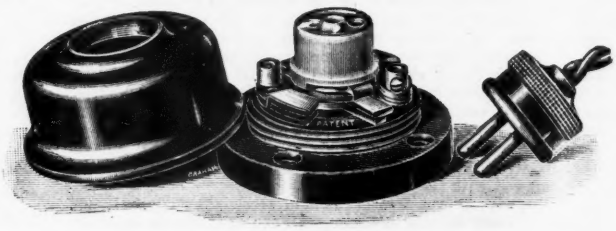
The Telegraph Manufacturing Company, Limited, of Helsby, publishes a new list of cables and wires for lighting, power, telephony, telegraphy, tramways, and other purposes. There are some opening comments respecting the use and abuse of electric cables, and also the selection of cables for specified purposes. Most of the other matter in the book is in tabulated form, and much time must have been devoted thereto. The Helsby wiring table, wiring under I.E.E. rules, standard wire gauge, dimensions, weight, &c., of conductors, concentric cables and mains of various sizes, Board of Trade concentrics, and so forth, are titles of some of these tables, and the prices per mile are given in all cases. Sundry accessorial articles have a place in the list, such as jointing tools, testing set, &c. A useful ready reckoner enables one to easily find the price for the shorter lengths from the price given per mile.

Crompton-Adams Commutator Polisher.—All those who have had much to do with dynamo machinery in every day work in the factories, workshops, and private houses where the electric light is in use, and is acquainted with the difficulties experienced in getting the men in charge to give the necessary attention to the commutators, will appreciate at a glance the value of the little tool invented by Mr. W. P. Adams. Such appliances should be a boon to all dynamo users, as few machines can do without occasional attention. The upper part, or holder, is divided into two parts, the hinder arm being solidly hinged, and provided with an adjusting screw. On the forward arm a clip is fixed to hold one end of the polishing cloth, and between the arms is stretched a thin flexible metal strip, generally of stencil copper. This is of such thickness that, when the polishing cloth is bent back beneath it and applied to the surface of the commutator, it will adapt itself to the curve of the surface, but will not allow the cloth to fall into the depressions, and so the whole surface is evenly scoured and polished, and at the same time kept perfectly true. The polisher is generally supplied a little less than the full width of the commutator to admit of a side movement, and the surface is kept perfectly level; thus it will be seen that where this tool is in use, the great inconvenience of turning up is never incurred; this in installations where there is no spare plant should render it very valuable. Even in these enlightened

days it is very far from common, if not actually the general practice in small installations, to use a flat piece of wood with emery cloth bound round it when the commututor requires scouring, and a flat shows signs of appearing, and we understand that many engineers, when giving their final instructions on the completion of an installation, recommend this course. This, however, is not a desirable procedure, as it has a tendency to make the commutator eccentric, particularly in a commutator given to forming flats in any given spot, and speedy demoralisation is ensured. A better plan, and about the only other one available prior to the advent of this new appliance, was to have a wood block turned hollow to a curve having the same radius as the commutator, and to apply the emery cloth on this, but as soon as the commutator began to wear it ceased to do its work properly, and began to have the same effect as the flat strip of wood. Arrangements are being made to supply suitable strips of polishing cloth with each appliance. They may be obtained from the General Electric Company. These polishers are of course suitable equally for the commutators of motors, and a special type for this purpose will be shortly introduced.

Electrical Engineering in Russia.—The Wuozen Electrical Company is the title of a company which has just been formed in St. Petersburg with a capital of 3,500,000 roubles, to acquire the right to certain water-power on the river Wuozen, in Finland, and to put down plant to utilise the same in the generation of electrical energy for lighting and power purposes. It is reported that Messrs. Brown, Boveri & Co., of Baden, Switzerland, are interested in the project.

High Voltage Fittings.—Mr. A. P. Lundberg writes as follows:—"Referring to a paragraph, 'Electric Fittings for 200 Volts,' appearing under 'Notes' in your issue of the 3rd inst., I notice combined switch and wall connections are severely criticised when used in connection with a high voltage supply, and it appears to me that the article may be the means of causing prejudice against fittings in present use, without just cause. Had the article stated that 'some' engineers of electric supply companies objected to these combination fittings it would have been more correct, otherwise where do all those supplied go to? Judging from the statement referred to, it would appear that those in use have been installed contrary to the supply company's wishes. Surely such a statement must be misleading, and likely to handicap their adoption in many quarters,



coming as it does from such an influential source? As the original introducer of the type of combination fitting referred to, I may say that since its introduction several years back, out of the many thousands sold, but few objections have ever reached me respecting the combination; and the demand for it, like other necessary adjuncts to electric lighting, has considerably increased, consequently it has been improved to meet present day requirements. I have lately been supplying the 'improved pioneer' switch, combined with a wall connection (both single and double break) in large quantities, and so far no adverse criticism as to their adaptability for high voltage circuits has yet reached me. In these patterns the parts are not inconveniently crowded, and should the smaller size be thought so, the larger size cannot help but fulfil all conditions." Mr. Lundberg sends us samples of the two sizes he is supplying, both of which are fitted with double break (which allows the current being broken from both poles. These, he claims, will be found to answer all requirements.

Edwards's Air Pump.—We have before us a pamphlet describing at considerable length, by the aid of diagrammatic and sectional drawings, Edwards's patent air pump, for which no foot or bucket valves are required. The patentee is Mr. Frederick Edwards, M.I.N.A., of 62, Bishopsgate Street Within, E.C. In this pump the condensed steam flows by gravity into the base of the pump; when the bucket descends the point of the cone enters the small amount of water which has to be lifted, silently, and without shock, and there is thereby given to the water a high velocity, which carries it up through the ports in the barrel. The water travels at such a high velocity, that much of it hits the valve-seat. In fact, in some of the larger glass models used, when the valve-seat and cover are removed, some of it will strike the ceiling of the room, a height of about 9 feet. The return, or upstroke of the bucket, closes the ports, and the rising water is followed by the rising bucket, and discharged through the valves at the top of the pump. The lower part of the pump is so constructed, that the water passes through the lower parts of the ports, the upper portions being left clear for the perfectly free entrance of the air. Neither gravity nor pressure is required to make the water pass into the barrel, and therein lies one of the essential differences between this and other pumps. It is claimed that the pump gives good results at as low as 20 revolutions per minute, and the higher the speed, the more efficiently the water is dealt with. The amount of air passing through the pump could not lead to a breakdown at any speed, and so far as the water is concerned, there is stated to be no risk whatever attached to driving it at a very high speed We understand that Mr. Edwards is preparing a special design for electrical stations, so arranged, that as the requirements of the station increase, more pumps can be conveniently added to existing ones.

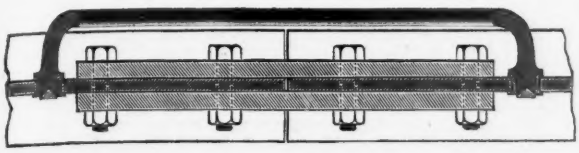
New Company.—We are asked to state that a new and entirely separate company has been formed under the title of Sax, Slatter & Co., Limited, to take over and extend the business formerly carried on under the style of Julius Sax & Co., Limited, at Forester's Hall, Clerkenwell Road, E.C. A new catalogue is in the press. This department will be carried on under the management of Mr. H. Jenson, as heretofore.

New Firm.—Messrs. Blakey & Smeaton have opened offices and showrooms at Albany Buildings, 39, Victoria Street, S.W., as engineers and contractors. Mr. Blakey was for several years on the staff of J. G. Statter & Co., 68, Victoria Street, and also with F. A. Robinson & Co., 54, Old Broad Street, the London agents of J. Hubert Davies, of Johannesburg. Mr. Smeaton was on the staff of Woodhouse & Rawson, and since then has had a large experience in West End installation work.

Tudor Accumulators.—We understand that the Tudor Accumulator Company has been registered, with a capital of £50,000, to take over as a going concern the business of an electrical engineer and manufacturer of accumulators, carried on by Mr. Antoine B. Pescatore at 5, Cross Street, Manchester, and at the Barn Meadow Works, Dukinfield, to acquire certain patents of Henry O. Tudor, and to carry on the business of electricians, &c.

The Columbia Rail-Bond.—It being of great importance in the construction of an electric tramway that the bonds, no less than other parts of the structure, should be substantial and perfect, the merits of the Columbia rail-bond claim attention. As will be seen from the figure, the bond consists of three parts, two copper thimbles and the connecting copper rod. On each end of this copper rod is a truncated cone-head, with a fillet at the base. The inside

of the thimble is tapered to fit the head on the bond, while the outside is slightly tapered in the opposite way. In applying the bond, the cone-shaped heads are placed in the holes in the rail from one side, and the thimbles are slipped over them from the other. A portable hand-press is then applied, and the wedge-shaped head of the bond is forced into the thimble, so that it is not possible to see the line separating the thimble and the head in a cross-section of the



two. The end of the head of the bond is expanded by a centre-punch, held in position in the press. When installed, owing to the pressure exerted between the head and the thimble, and also to the fact that they are of the same kind of metal, the two become one, both electrically and mechanically. It is claimed, therefore, that it has all the advantages of a one-piece bond, and at the same time can be satisfactorily installed, as no riveted bond can be. Samples and particulars can be obtained of Messrs. Back & Manson, 36, New Broad Street, London.

ELECTRIC LIGHTING NOTES.

Aberdeen.—The Watching and Lighting Sub-committee on 14th inst. visited several thoroughfares in which it is considered that improved lighting is required, and arranged for several small alterations and additions to the lamps.

Armagh.—The Town Commissioners have postponed taking active steps in regard to electric lighting on account of the cost.

Ayr.—In his monthly report for August, Mr. Fuller says that the sub-stations are now finished and are all working quite satisfactorily. Owing to the engineering strike the transformers will not be delivered to time, but they can be managed without for a little while. The number of applications for lamps is over 8,000, as follows: Connected May 31st, 7,139; connected since, 658; now in hand, 500. In the matter of the extensions the foundations of the works are ready for the machinery; the boilers are erected; the condenser is fixed and the pipes connecting it to the existing system are being fitted. From September 13th current has been obtainable throughout the day.

The financial state of the electric lighting undertaking is seen from the following report recently made to the Council: "Although there is unfortunately a large deficiency on this year's working, I do not think this will continue. I expect that, when all our extensions are completed, and our new engines in full working order, we shall be able to make a profit instead of a loss within the next few years. With reference to the outstanding accounts at May 31st, I would explain that as our fourth quarter ends on that date, there is of course that quarter's accounts included in the sum outstanding. At this date the greater portion of the sums outstanding has been paid."

Batley.—Last week, at a private meeting of the Town Council, it was decided to apply for a provisional order for electric lighting.

Brechin.—The Police Commission will hold a special meeting to consider whether to apply for a provisional order.

The deputation which has been inquiring into the question has submitted its report, in which it enters into full details as to the system of the Shropshire Electric Light Company, and those at Kingston-on-Thames and Charing Cross.

Bradford.—The half-yearly accounts of the Gas and Electricity Committee show that during the year ended June 30th the electricity department has had a total income for that period of £8,726, an increase of £1,789. The total expenditure, including interest on loans, had been £7,061, as against £5,929 for 1896. The profit had been £1,665 as against £1,007 for 1896. The consumers numbered 591, as against 391, an increase of 33¼ per cent. The total units of power supplied had been 443,288, as against 336,281, an increase of 31¼ per cent., whilst the total profits since the opening of the works in 1889 had been £13,883.

Bromley.—The Bromley Electric Lighting Power Company is to be registered shortly with a nominal capital of £20,000 in shares of £5 each, and the signatories to the Articles of Association will include Mr. F. E. Gripper, managing director of Edmundsons, Limited.

The agreement for the transfer of the provisional order, as submitted by the District Council, has been approved by the signatories of the proposed company, among whom are Messrs. R. Taylor, F. Medhurst, I. Uridge, F. E. Gripper, W. R. Bassett, G. H. Cakebread, and John King. A suitable site for the erection of works is available and the plans are in course of preparation, and as soon as the form of transfer has been approved by the Board of Trade, the business will be immediately set about. The company will be registered forthwith, and at a later stage the investors of Bromley will be asked to contribute for shares.

Brighton.—The Council have resolved to apply to the Local Government Board for sanction to borrow an additional sum of £500 for the purpose of public street lighting, the original of £14,000 for this purpose having been exceeded.

Bo'ness.—At the last meeting of the Harbour Commissioners, the engineer reported on this matter of electric lighting remitted to him, giving probable cost of a complete installation and the probable cost of lighting all the year round. The meeting after considering the report and the figures therein given asked the engineer to submit a further report thereon to the next meeting.

Burnley.—The Corporation contemplate an extension of the electric lighting scheme which will involve an expenditure of over £25,000. Plans of the proposed extension are now being prepared.

Cambridge. — When the basement of the Guildhall Street wing of the new municipal buildings was constructed, the Cambridge Electric Supply Company were given permission to use a certain chamber for purposes connected with the electric lighting of the Guildhall buildings. The Council now finds that the company is using the chamber as a sub-station in connection with the lighting of a number of other premises as well, and a charge of £10 per annum for rent is to be made.

Chelsea.—The surveyor to the Chelsea Vestry in his annual report for the year 1897, gives the following details regarding the electric lighting of the district:—"The number of houses in Chelsea lighted by electricity for the last three years was as follows:—

	1894-5.	1895-6.	1896-7.
Chelsea Electricity Supply Company	598	777	1,032
London Electric Supply Corporation	9 (?)	[No information.]	

On June 23rd, the Board of Trade issued an order directing that the portion of the parish west of Beaufort Street should be added to the area of supply of the Chelsea Electricity Supply Company. The whole of the home district can now be supplied with electricity by this company. *Pressure Records.*—From time to time, I examine the records which show at what pressure the supply is given to consumers by the Chelsea Electricity Supply Company. As the network of mains increases, the pressure becomes more constant, and the supply seems most satisfactory."

Cheltenham.—Last week (Thursday) another step was taken in the street lighting by electricity, the lower part of High Street, from St. George's Square to the Gloucester Road, being supplied with arc lamps in the same proportion as other parts of the town. The use of the electric light by private consumers is increasing rapidly. So great, indeed, is the demand that it cannot be met by the existing plant, and additional machinery is urgently needed.

Chester.—A Local Government Board inquiry was held on 16th inst. *re* an application of the Town Council for sanction to borrow £20,000 for the purposes of electric lighting.

Chichester.—At a meeting of the Town Council last week, the Finance Committee recommended that with a view to the City keeping in its own hands the power for supplying electricity for lighting and other purposes, the Council should take steps to procure a provisional order. Councillor Mant said that according to a letter he had received from the Board of Trade, it would be necessary under a provisional order to proceed with the erection of works within two years or the order would be cancelled. He did not consider it an opportune time to go in for electric lighting schemes, and he therefore moved as an amendment that no steps be taken at present to apply for a provisional order or in giving sanction to the speculation of any private company. Councillor C. Ballard seconded the amendment, but after some discussion the amendment was withdrawn in favour of a proposition to ascertain from the Board of Trade the longest period for which a provisional order could be granted.

Chislehurst.—At a meeting on Friday it was reported that the Chislehurst Electric Lighting Company, having found some difficulty in acquiring a site for works at Chislehurst, it had been decided to have the current from Bromley, where very large works were to be erected as soon as the transfer of the provisional order from the District Council to the local syndicate has been approved of by the Board of Trade.

Coseley.—After considering whether to apply for a provisional order for electric lighting, the Coseley Council last week, by a majority of one vote, decided to defer the matter for a month. The chairman said that three companies were seeking powers. The Council were told that an outlay of £10,000 would be sufficient to light the district and supply 2,000 customers.

Dingwall.—The Town Council last week adopted the recommendation of a Committee to the effect that Mr. Yorke's offer to light the town electrically for £62 per annum, subject to certain modifications, be accepted.

Dublin.—The *Daily Nation*, of Dublin, is responsible for the statement that the Electric Lighting Committee of the Corporation have at last recognised that the entire length of the electric main used for street lighting has become defective. As a result, the cable must be at once replaced at a cost of over £10,000.

Fleetwood.—At the last Council meeting the Clerk read a letter from Mr. Medhurst, on behalf of the company who had acquired the Fleetwood Electric Lighting Order, stating that he was coming to Fleetwood shortly to make observations on his own account in view of an early commencement with the operations.

Hammersmith.—At the last meeting of the Vestry, it was reported that the electric light would be ready by October 20th. A banquet will be held on October 28th to celebrate the completion of the Town Hall and the installation of the electric light. There is to be an electrical exhibition on September 30th in connection with the inauguration of the public street lighting.

Huddersfield.—The Board of Guardians has accepted the tender of Messrs. Reed, Holliday & Co., for an installation of the electric light at the union offices.

Hull.—The Electric Lighting Committee have a vacancy for an improver in their works. See our "Official Notices."

Ilford.—The Electric Lighting Committee has reported that 17 applications were received from "specialists" giving terms for which they would advise the Council as to the proposal to light Ilford by electricity. The Committee recommended that certain of the applicants be asked to attend a special meeting of the Council and discuss the question. The Council agreed to this.

Leytonstone.—Last week Lady Birt switched on the current for illuminating three new dials which have been fitted to the Parish Church clock. The installation for the purpose, as well as the cost of the dials themselves, was paid for out of a Jubilee commemoration fund.

Liverpool.—Mr. A. B. Holmes last week reported to the Lighting Committee that during August the equivalent number of 16 C.P. lamps connected with the supply main was for private lighting 53,878, and for Corporation lighting 4,898, a total of 58,776, being an increase of 800 for the month. The number of units supplied during August to private consumers was 83,260, and to the Corporation 21,356, making a total of 104,616, as against 63,690 in the corresponding period of last year. An extension of mains in Ivanhoe Road, Bertram Road, Scotland Road, and Belvidere Road was authorised. The sanction of the Local Government Board to the borrowing by the Corporation of £56,000 for electric lighting purposes has been received.

London.—At last Tuesday's meeting of the Commissioners of Sewers a letter was read from Messrs. Ashurst, Morris, Crisp & Co., in which they declined to agree to the deduction of £1,142 2s. 7d. from the account of the City of London Electric Lighting Company, as the expenses in connection with the office of electrical inspector. The company, it was stated, did not admit their liability in that respect, and asked for the payment of the full account, namely £6,344 8s. 2d. The committee was asked to pay the account during the ensuing week, in default of which a writ would be issued. Mr. McCarthy asked why the expenses of the electrical inspector should be charged against the Board. The Chairman replied that the order was made some time ago by the committee. Mr. Turner said, as the Court had deliberately made the order, there was no alternative but to leave the matter in the hands of the solicitor. He moved that the solicitor should be instructed to defend any action. Mr. Burmester seconded the motion. It was carried unanimously.

We understand that the Paddington and Marylebone Vestries, who jointly control Edgware Road from the Marble Arch to Praed Street, are to light that thoroughfare by means of electric arc lamps. The cost will be divided equally between the vestries.

London County Council and Electrical Matters.—The annual report of the Highways Committee of the London County Council just issued, deals in detail with the various matters of electrical interest coming before the Council in the past year. A full draft of the lease granted to the North Metropolitan Tramway Company of the tramways is given, in which provision is made for the introduction at a future date of electrical traction. Six applications were made to the Board of Trade for electric lighting provisional orders in the session of 1897, viz.: Fulham (applied for by Vestry), Newington (applied for by Vestry), Blackheath and Greenwich District, County of London (Northern Extension), County of London (East), and London Electric Supply Corporation (Westminster). With respect to the electric meter testing station the report says the Council's officers have for many months been engaged in the examination of various meters in conjunction with the officers of the Board of Trade, and the noting of their performance under ordinary working conditions has been continued during the past year. 34 meters have been under observation for this purpose, and all of these have been tested at Cranbourne Street before being fixed on consumers' premises. Only two meters of the alternating current type approved by the Board of Trade have this year been tested for certification. During the year 149 meters of various patterns, the accuracy of which was in dispute, have been tested at the station, and all of these have also been examined at the consumers' premises; 364 meters have been tested for electic supply companies, found to be correct and sealed accordingly, and 436 tests have been made for the meter manufacturers. The amount of the fees received during the year 1896-7 was £645 11s. This sum does not, however, include anything for the Board of Trade meter tests, for which no charge is made. Dealing with notices under the Electric Lighting Acts and Orders, the Commitee state that the Council has, since the date of the last annual report, received and dealt with 232 notices, some of which referred to works extending over large areas; and each of these notices has been separately considered, and where necessary, special conditions have been attached to the Council's consent. The Council has, during the year, sanctioned the laying of about 117 miles of mains in streets and roads, in addition to innumerable service lines to particular consumers. Of these mains those in 5 miles of streets were for currents of high tension, and in 112 miles for those of low tension. The Council has in all cases required that the mains should be laid under the footways wherever it was found practicable to do so, and that the covers of the street boxes should consist of iron frames filled in with the material to suit the paving. The Council also requires that where high tension mains other than concentric cables are used, each of the street boxes shall be provided with an inner as well as an outer cover, the two being insulated from each other as far as practicable, the outer cover being efficiently connected to earth, and that adequate precautions shall be taken to prevent the accumulation of gas in the boxes and conduits, and any risk of accident through defective insulation of mains. As stated in previous reports, a system of supply has been adopted under some electric lighting orders which involves the construction of transformer boxes or converting stations of very large dimensions, to be placed under the public thoroughfares. The Council took exception to this proposal for the appropriation of large portions of the space under the streets for this purpose, there being, in its opinion, no necessity for such appropriation, as the requisite provision might be made upon private ground. The Board of Trade overruled the Council's objection, and the Council has in consequence, when dealing with applications of this nature, given its consent, upon the conditions laid down by the Board of Trade when deciding on the case submitted to it. The Council requires that in connection with any notices for the construction of transformer boxes, full particulars and plans must be supplied, showing the exact position to be occupied by, and the internal and external dimensions of, each of the boxes proposed to be constructed, and also the existing works which will be disturbed thereby.

Lowestoft. — A report on the subject of the electric lighting of the borough is to be prepared by Mr. W. C. C. Hawtayne, consulting electrical engineer.

Montrose.—Last week there was considerable discussion at the Town Council on a motion to apply for a provisional order for electric lighting, and make it over to Edmundsons, Limited, electricians, London, to carry out the installation. Finally, the proposal was carried against an amendment for delay by 14 to 3.

Morecambe.—At last week's council meeting the plans of the proposed electric lighting works, mains, &c., and the draft contract with Messrs. Parker, Ltd., were produced and discussed, and it was resolved that the date for the completion of the work be February 1st, 1898. Mr. C. A. Parkinson, of Morecambe, was appointed resident electrical engineer, and Mr. Albert E. Bradley was recommended for appointment as inspector for the works.

Newington.—At a meeting of the vestry last week, the Electric Lighting Committee recommended that application should be made to the London County Council for permission to erect a generating station to the Fore Court line of the vestry's property in Penrose Street; that the committee be empowered to inspect the St. Pancras, Westminster, Brighton, and other stations. The recommendations were adopted.

Newport.—A long report, covering 12 foolscap pages, was presented at the last City Council meeting, dealing with the way in which the new loan of £30,000 or £35,000 obtained for the extension of the electrical installation in the borough had been applied. Some tenders for plant, &c., were accepted, as stated under "Contracts Closed."

Northampton. — Major-General Scott, one of the Arbitrators of the Board of Trade, attended at the Northampton Town Hall recently, to arbitrate in the matter of the Northampton Electric Light and Power Company, Limited, and the Northampton Gas Light and Coke Company. The Electric Light Company, who, it was stated, had now nearly 2¼ miles of culverts in the town, had, it was explained, uniformly made deep culverts, deep enough to permit the service pipes of the Gas Company to go over them. Deep culverts, however, says the *Northampton Mercury*, are expensive, extremely difficult to inspect, and consequently dangerous from possible accumulations of gas, liable to accumulations of water, and from their general inaccessibility, an inconvenience to the public. Mr. Browne, in the course of his opening remarks, pointed out that though the extra expense of deep culverts—£190 a mile—fell on the shareholders, ultimately it would fall on the ratepayers, who would eventually undoubtedly become the owners of the company. At the present time he had a proposal from the Corporation to purchase the company. The Electric Light Company now asked the arbitrator to decide in certain streets mentioned, that for the future they should be able to depress the service pipes of the Gas Company so that the electric light culverts could be made above them. All expenses of alterations would of necessity be paid by the Electric Light Company. On the part of the Gas Company it was stated that no impediment had ever been placed in the way of the Electric Light Company altering the gas service pipes, if it could be done without detriment to the gas supply. Generally, however, the mains in Northampton were not very deep, and a depression of the service pipes would mean that the fall in their level would be from the main to the house, instead of from the house to the main. The result

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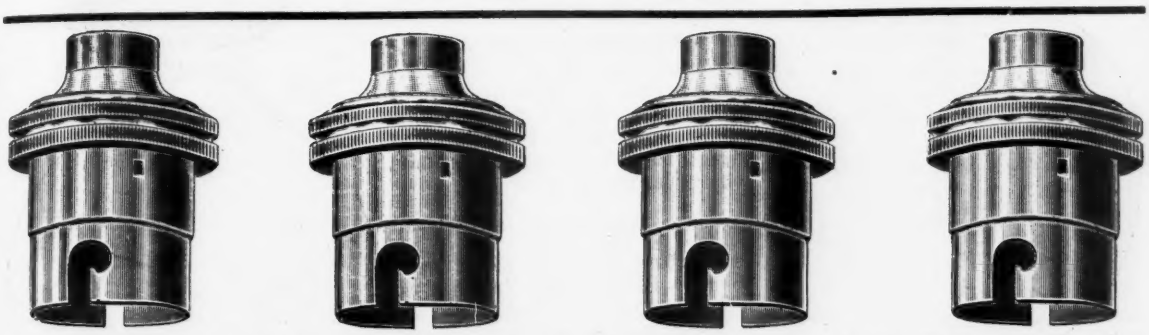

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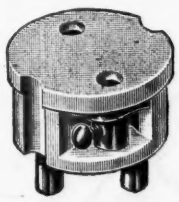

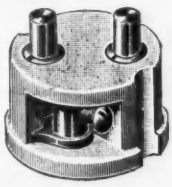

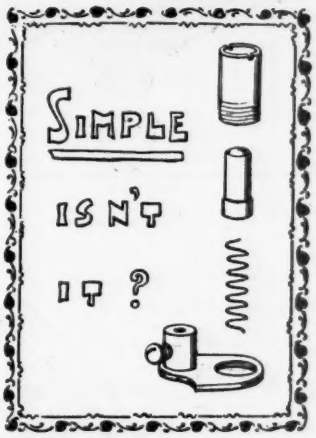

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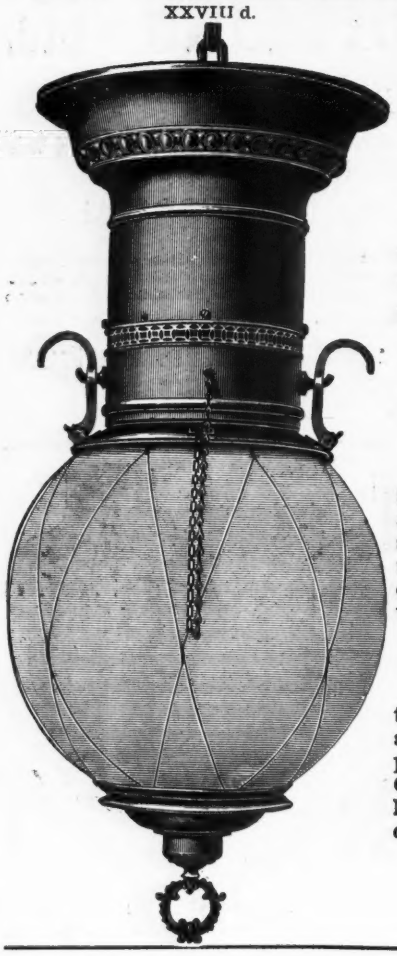

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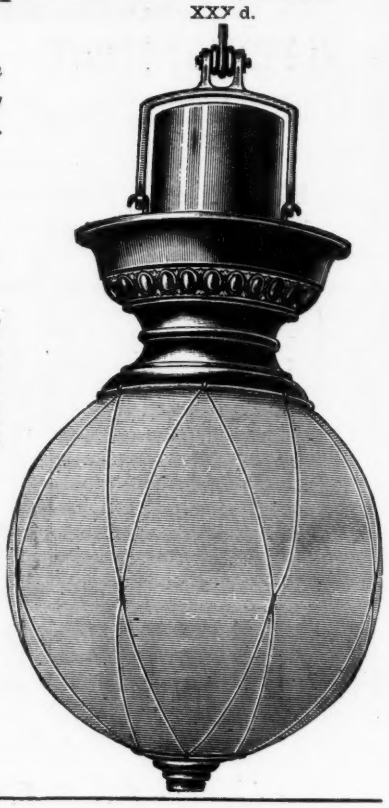

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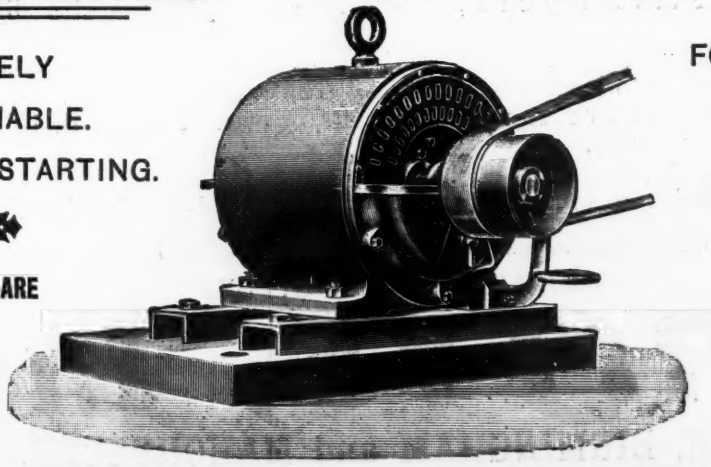

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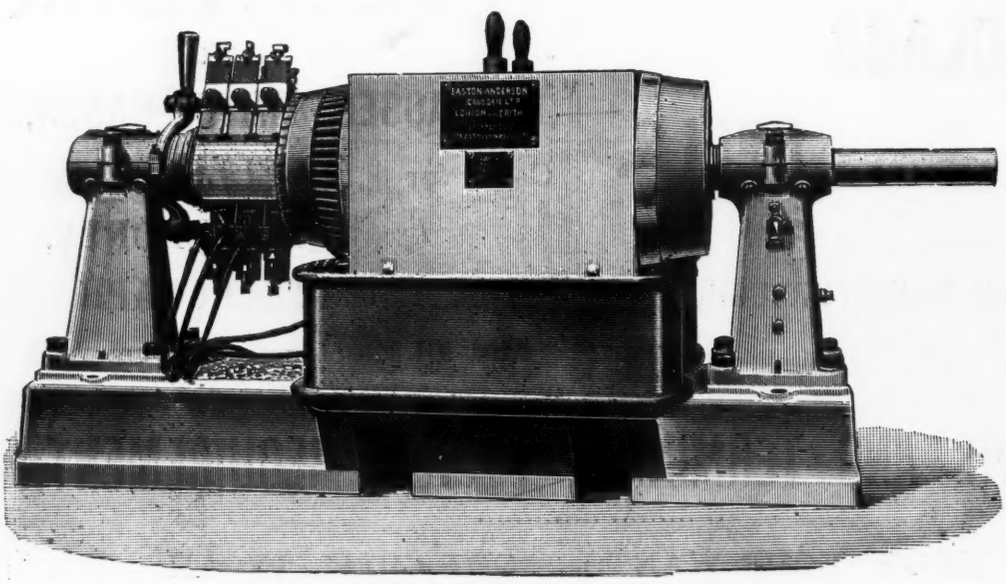

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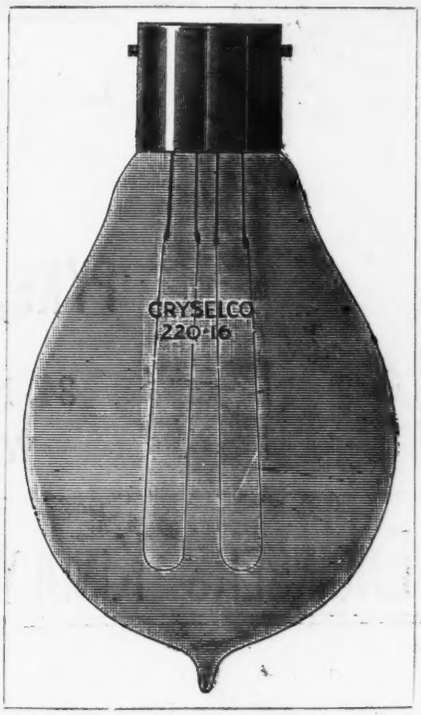

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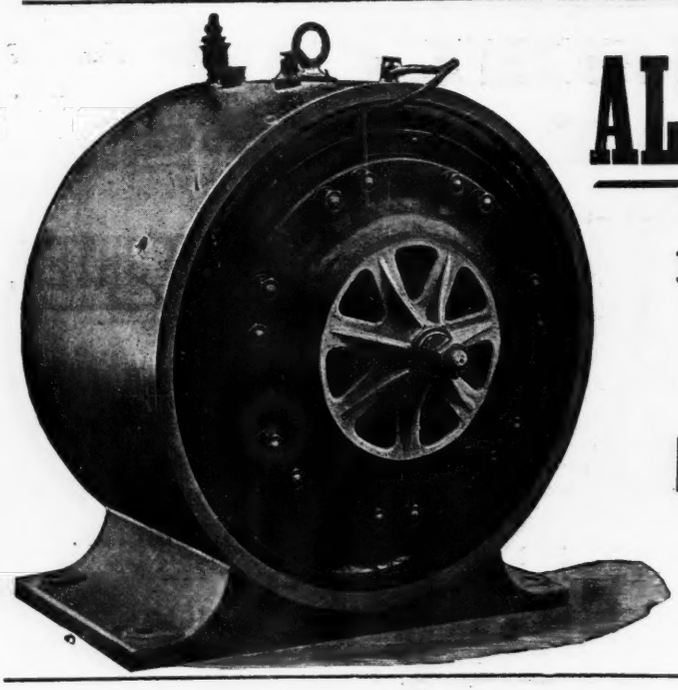

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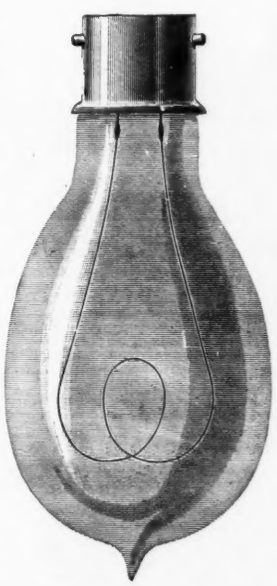

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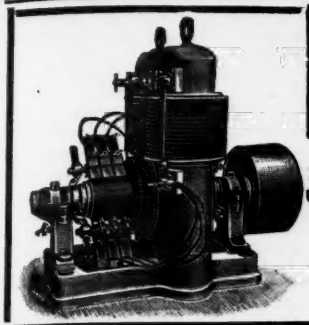

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PARTNERSHIP WANTED.—An Electrical Engineer, with 20 years' experience of general electrical engineering, and who could introduce business, is desirous of obtaining a partnership in an established firm of consulting engineers, who would be disposed to add an electrical branch to their existing business.—1,631, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 1631

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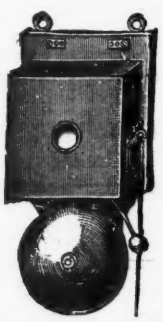

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Official Notices.

COUNTY BOROUGH OF SOUTHAMPTON.

ELECTRICITY SUPPLY.

CONTRACT No. 4.

THE CORPORATION OF SOUTHAMPTON invite tenders for the supply and erection of:—

Section A.—Engines and Alternators, Motor-Alternator, Rectifiers, High-Tension Switchboards.
Section B.—Engines and Continuous Current Generators, Balancing and Volt-raising Transformers, Low Tension Switchboards.
Section C.—Battery of Accumulators and Accessories.

Specifications and forms of tender can be obtained on and after SEPTEMBER 27th, 1897, at the Municipal Offices, Southampton, or at the Offices of the Engineers, Messrs. Kincaid, Waller & Manville, 29, Great George Street, Westminster, on payment of a fee of £3 3s., which sum will be returned on receipt of a *bonâ fide* tender. The contractor will be required to pay not less than the minimum standard rate of wages for the time being in each branch of the Trade.

Contractors may tender for any one of the Sections or the Three Sections complete, but the Corporation will not consider any tender for a part of a Section only.

The Corporation do not bind themselves to accept the lowest or any tender, and the contractor whose tender is accepted shall enter into a formal agreement, under seal, with sufficient sureties for the due fulfilment of his contract.

Sealed tenders endorsed "Electricity Supply Contract No. 4," must be sent to me at or before 2 p.m. on MONDAY, OCTOBER 18th, 1897.

GEORGE B. NALDER,
Town Clerk.
Municipal Offices,
Southampton, *September*, 1897. 1628

GLASGOW CORPORATION TRAMWAYS.

ELECTRIC TRACTION.

THE CORPORATION OF GLASGOW are prepared to receive tenders for the Electrical Equipment of the Springburn and Mitchell Street route. Specification, with form of tender and plan of route can be obtained on application to Mr. JOHN YOUNG, General Manager, 88, Renfield Street, Glasgow.

Intending offerers must remit to the General Manager the sum of £10, by bank draft, payable to Glasgow Corporation Tramways, and this sum will be returned to them on receipt of a *bona fide* tender, together with the plan of route.

Sealed tenders, marked "Springburn and Mitchell Street Route, Tender for Electrical Equipment," to be lodged with the subscriber, not later than 10 a.m. on WEDNESDAY, OCTOBER 20th next.

The Corporation do not bind themselves to accept the lowest or any tender.

J. D. MARWICK,
Town Clerk.
City Chambers, Glasgow,
September 21st, 1897. 1627

Official Notices.

HULL CORPORATION ELECTRIC LIGHT WORKS.

TO IMPROVERS.

THE ELECTRIC LIGHTING COMMITTEE of the Hull Corporation have a vacancy for an Improver in their Works for a period of two years.

Information as to necessary qualifications, premium, &c., can be obtained on application at my office, and applications are to be addressed to the Chairman of the Electric Lighting Committee, and delivered at the Town Clerk's Office, Town Hall, Hull, not later than THURSDAY, OCTOBER 7th, 1897.

By Order,

A. S. BARNARD,
City Electrical Engineer.

Dagger Lane, Hull,
September 17th, 1897. 1615

BOROUGH OF PLYMOUTH.

THE PLYMOUTH CORPORATION is prepared to receive Tenders for the undermentioned Engineering Works, in connection with the Tramways of the Borough, viz.:—

Contract No. 10.—Overhead Trolley Line, Posts, Brackets, &c.

Contract No. 11.—Tramcars, Trucks, Motors, Trolley Arms, &c.

Contractors may tender for either of the Contracts, but not for a part of any Contract.

Copies of the conditions, specifications, and forms of tender, bound up together, may be obtained from the undersigned on the deposit of Two Guineas for each copy, which will be returned on receipt of a *bonâ fide* tender upon the prescribed form, and within the stated time.

Should a contractor withdraw his tender, the amount of his deposit will be forfeited.

A copy of the drawing of posts will be sent to those wishing to tender for Contract No. 10.

Sealed tenders, endorsed "Engineering Contract No.....," must be delivered to J. H. ELLIS, Esq., Town Clerk, Plymouth, not later than the 2nd day of October, 1897.

The Corporation does not bind itself to accept the lowest or any tender.

The acceptance of any tender will be subject to the contractor paying the standard rate of wages obtaining in the district where the work may be carried on.

JOHN H. RIDER,
Borough Electrical Engineer.

East Street, Plymouth.
September 6th, 1897. 1539

MUNICIPALITY OF IPSWICH, (QUEENSLAND).

ELECTRIC LIGHTING.

THE COUNCIL OF THE MUNICIPALITY OF IPSWICH (Queensland) are prepared to receive Tenders for the Supply and Erection of the following plant:—

Section A.—Tubular boilers.

Section B.—Feed, Steam, and Exhaust Pipes, Pumps and Heaters.

Section C.—Steam Alternators and Exciters.

Section D.—Switchboard.

Section E.—High and Low Tension Mains, Junction Boxes, &c.

Section F.—Transformers.

Specifications for the above, with general conditions of the contract, may be obtained on application to the undersigned, or at the offices of Messrs. GORDON & GOTCH, St. Bride Street, Ludgate Circus, London, E.C.

The Council reserve the right to accept the tender of any contractor for any one or more of the Sections, and they do not bind themselves to accept the lowest or any tender. Tenders, marked "Electric Lighting, must be delivered to the undersigned at the Council Chambers, Ipswich, Queensland, not later than noon on MONDAY, NOVEMBER 15th, 1897.

ALBION HAYNE,
Town Clerk. 1544

Official Notices.

CITY OF WAKEFIELD.

THE CORPORATION OF THE CITY OF WAKEFIELD are prepared to receive Tenders for the Electric Light Wiring of the Town Hall. Plans can be inspected, and copies of the specification and conditions of contract can be obtained at the Town Clerk's Office on payment of a deposit of 10s., which will be returned on receipt of a *bonâ fide* tender.

Tenders are required to be sent under cover addressed to the Town Clerk, Wakefield, and marked "Tender for Electric Wiring," on or before SATURDAY OCTOBER 2nd, 1897.

The Corporation do not bind themselves to accept the lowest or any tender.

CHAS. JAS. HUDSON,
Town Clerk.

Town Hall, Wakefield,
September 18th, 1897. 1616

COUNTY BOROUGH OF BURNLEY.

THE ELECTRIC LIGHTING COMMITTEE are prepared to receive applications for the appointment of Assistant Electrical Engineer and Manager, who must be capable of taking charge of the electric lighting station, and of acting as General Assistant.

Applicants should be good draughtsmen and be competent to test mains, meters, &c. Salary £2 per week.

Applications endorsed, "Assistant Engineer," stating age and previous experience, together with copies of not more than three recent testimonials to be forwarded to the Electrical Engineer, Mr. W. R. WRIGHT, at the Electric Lighting Station, Burnley, not later than 10 a.m. on TUESDAY, OCTOBER 5th, 1897.

WM. T. FULLALOVE,
Town Clerk.

Town Hall, Burnley,
September 20th, 1897. 1640

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A GENTLEMAN is required to take charge, under the Superintendent of the College, of the Department of Electrical Engineering and Telegraphy (including Telephony). He will be required to teach classes in these subjects, and he will have an Assistant. The principal work of his department will be training telegraph and telephone operators for the Government Postal and Railway Departments. Engagement, in the first instance, for three years. Salary Rs. 4,200 per annum (the present rate of exchange is about 1s. 3d.)

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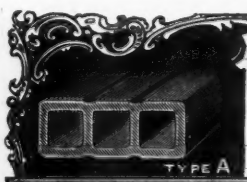
2. Must have served two years in the workshops and one year in the drawing office of a good electrical engineering firm.
3. Must have a practical knowledge of telegraphy and telephony.
4. Must have been teaching for not less than one year some of the subjects comprised in a college course of mechanical or electrical or telegraphic engineering.
5. Age must be from 25 to 30 years.

Free first-class passages for himself and family (if any), not exceeding five in all, out and home again, on satisfactory termination of engagement.

Applications, stating age and experience, and accompanied by copies of testimonials (not originals) with the names and addresses of references of whom enquiry may be made, will be received by the Crown Agents for the Colonies, Downing Street, London. S.W., up to OCTOBER 13th, 1897.

The Crown Agents possess no further particulars respecting this appointment, and cannot, therefore, undertake to answer enquiries. 1635



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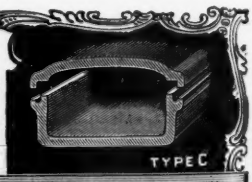

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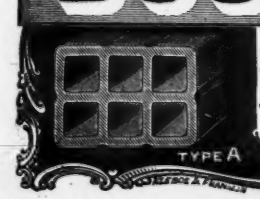

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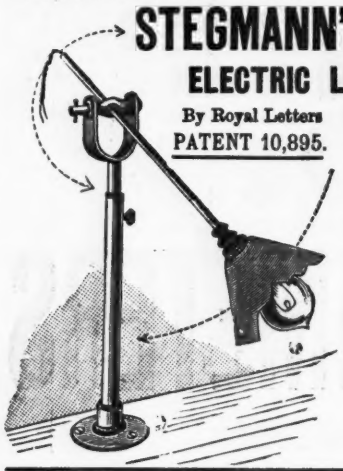

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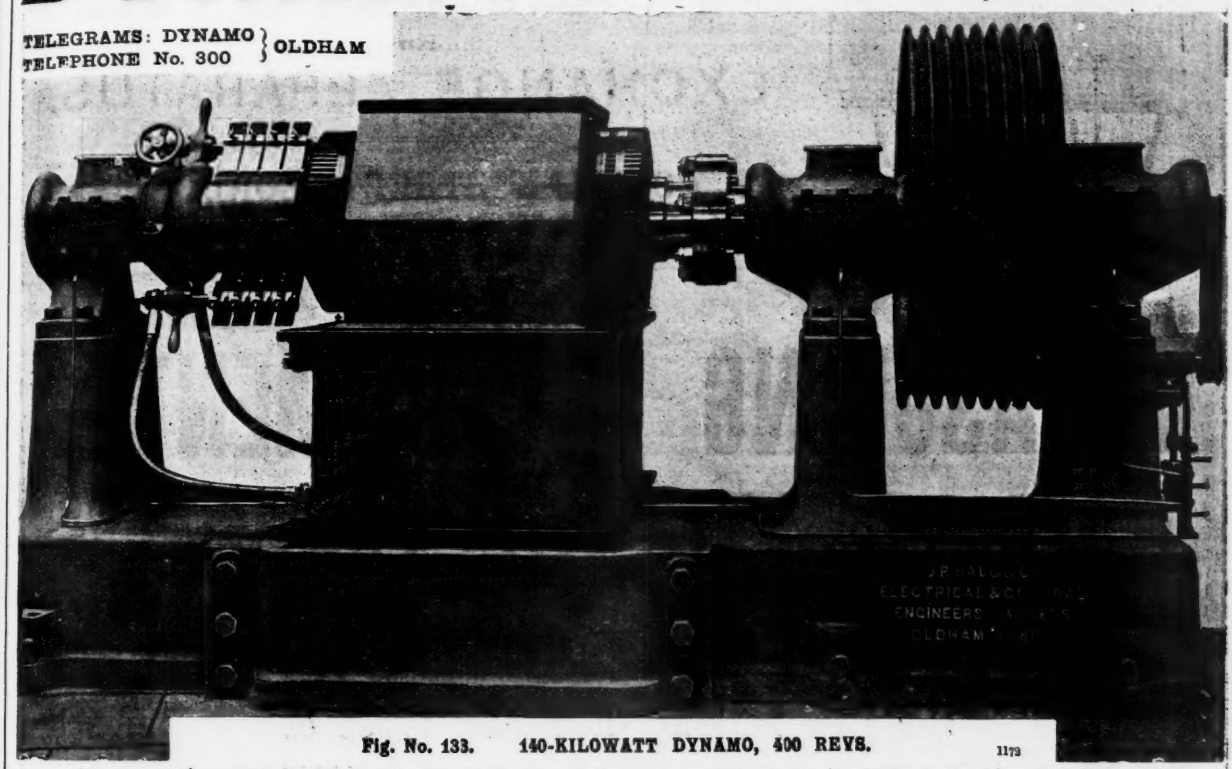

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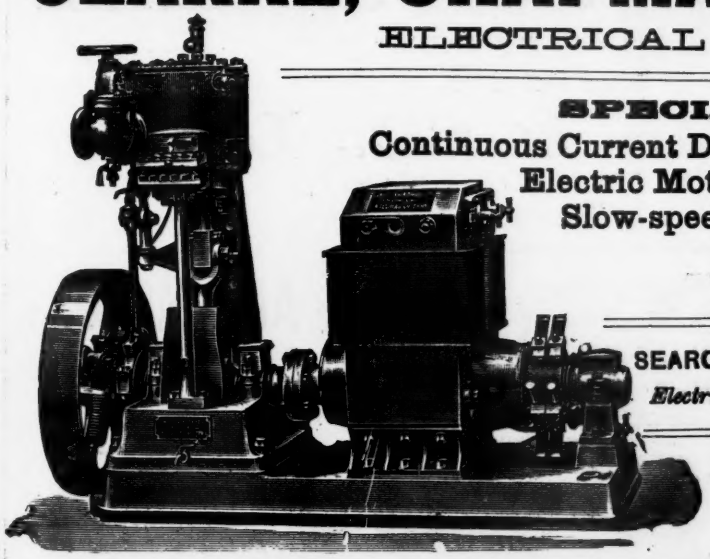

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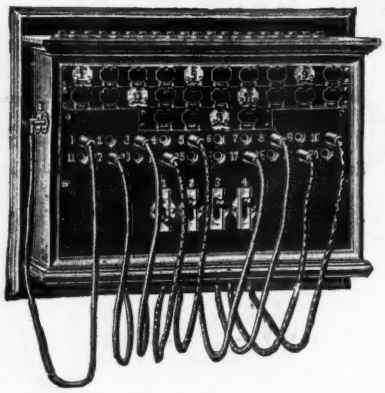

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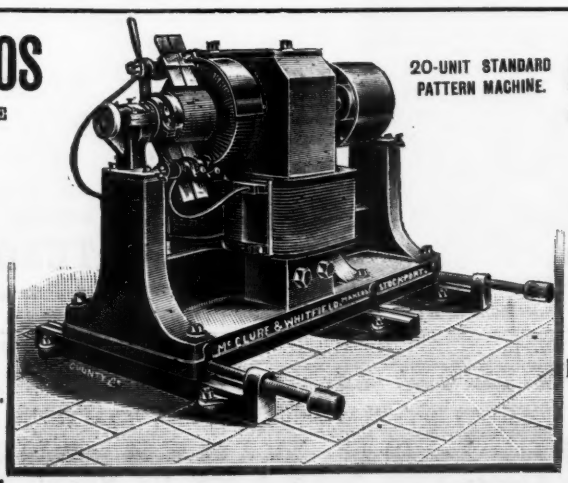

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would inevitably be that very soon water would collect in the service pipes, and the supply of gas would be stopped. The Gas Company did not offer any serious objection to the alterations being made in those places where they felt it could be done safely. The difference between the parties, as disclosed in the arbitration proceedings, was chiefly as to the relative depth the gas main must be in regard to the electric light culvert to enable the gas service pipes to the houses to go under the electric light culvert. The witnesses called for the Electric Light Company went to show that by connecting the service pipes with the middle and not with the top of the gas main, practically in every case where the top of the gas main was not higher than the bottom of the culvert, the service pipes could safely be taken underneath. Mr. Eunson, the manager and engineer of the Gas Works, explained that in Northampton the service pipes were connected with the top of the gas main, that being the best and most economical method. He considered that it was not absolutely safe to have less than six inches between the top of the gas main and the bottom of the electric light culvert, but he would be able to manage, he thought, with a minimum of four inches. The Arbitrator said that he would deliver his opinion in due course: he did not think there would be much delay.

Paisley.—At the suggestion of Mr. Teague, the electrical engineer, the Electric Lighting Committee recommend certain extension of the St. James Street main at a cost of £35. He was instructed to prepare for the committee a detailed statement of the cost of the works as contracted for up to date, and an estimate of the amount required to complete them.

Paris.—It is stated that the Palais de Justice will, at the end of this vacation, be lighted with electricity. The lighting heretofore has been with small oil lamps with green shades.

Portsmouth.—The Town Council, at a meeting on Tuesday, discussed a report from the Electric Lighting Committee, who having had under consideration the desirability of providing additional machinery and plant to meet the demand for supply of the current beyond that which can be generated by the present plant for the winter of 1898, recommended that application be made to the Local Government Board for their sanction to borrow £40,000. Of this sum the committee stated about £21,000 would be required for 1898, and the balance later on; but it was thought that it would be a saving of expense if application for sanction to borrow the larger amount were made now. Of course, it was added, before any part of such balance was raised the matter would be submitted to the Council for approval. Alderman G. Ellis, J.P., chairman of the committee, in moving the adoption of the report, said they had now five boilers, four of which were in use, and the whole five would be in use before the winter. The committee considered that before the winter of 1898, they must have four more boilers. The extension of their business had been exceptional. He knew of no other installation in the Kingdom, except in London, where the growth had been so great and so rapid. After a brief discussion the committee's report was adopted.

Prescot.—The District Council discussed the lighting question at length some days ago, and ultimately gave the contract for the public lighting to the British Insulated Wire Company at £365 per annum for five years from January 1st next.

Redditch.—Last week Mr. McMullen submitted his scheme for the lighting of the town by electricity. It was resolved to commence operations at once, provided that a canvass of the town resulted in promises amounting to 1,800 lights.

Sheffield.—It is stated in the Sheffield press that the Sheffield Electric Light and Power Company, Limited, have been compelled to give notice to the public of their inability to accept any more electric light customers this year. The immediate cause of this serious step is the dispute in the engineering trade. Early this year the directors gave out orders for engines of 2,000 H.P. and dynamos to enable them to supply the requirements of the public during the coming winter; but the strike has prevented the delivery of these. The demand upon the company for electric light has increased by 100 per cent. since this time last year, and the directors now feel compelled to refuse further orders from consumers this year, so that the severe strain which is being put on existing machinery may not jeopardise the general supply of light to the public. It is also said that steps are being taken by the company for the introduction next year of American and Continental engines and dynamos, so that the risk of dislocation of an important public supply of light from causes similar to those now existing may in future be rendered impossible.

Southend.—The Electric Lighting Committee recommends the Corporation, if it adopts the electric lighting scheme, to appoint an electrical engineer at £250 per annum.

Smethwick.—The Clerk of the District Council has been instructed to take steps to obtain the necessary provisional order for electric lighting, and to oppose the applications of the private companies.

Stonehouse.—The District Council has decided to apply for a provisional order to supply electricity for use in the township.

Sunderland.—The new electric hoists which have been supplied for the central station by Messrs. F. Reid, Ferens & Co., underwent a satisfactory test last week. They are estimated to lift 1 ton in 25 seconds.

Taunton.—The Electric Lighting Committee reported to the last Council meeting that a letter from Mr. H. W. Couzens, the electrical engineer, dated August 18th last, had been received, resigning his appointment. The Committee recommended the Council to appoint Mr. Edward J. B. Thornhill as electrical engineer at a salary at the rate of £130 a year, subject to a month's notice on either side, and that the Committee be authorised to make arrangements with Mr. Couzens for visiting and supervising the works; Mr. Thornhill to have one half of the premiums paid to the Council by pupils taken during his engagement. They also recommended the Council to continue the employment of Mr. Herbert Couzens as assistant electrical engineer at £1 a week, provided he would undertake not to determine the appointment for six months. The report was adopted.

Train Lighting.—From an Indian exchange, we learn that the experiment of lighting the South Indian railway trains with electricity, which was carried out a short time ago, was considered so successful, that the agent has made up his mind to ask the board of directors to introduce the system of electric lighting over the whole line.

Whitehaven.—It was reported at the last Council meeting that the new electric light mains were giving every satisfaction. There had been no fault during the month.

Yarmouth.—At last week's council meeting eight arc lamps were ordered to be placed on the covered market, a circuit laid for lighting the outside of the front of the covered market with bulkhead lights, and an additional circuit for lighting the offices, the cost being £250. The annual cost of maintenance will be £130, against £100 now paid for gas. The electric lighting report for August stated that the number of customers had been increased to 228 for 11,050 lamps. The income was £313 10s., and the expenditure £183 1s. 6d., leaving a balance of £130 8s. 6d. to meet capital and other charges of £180 per month.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Burnley.—The Parliamentary Committee of the Burnley Corporation have decided to seek powers next Session to work the tramways should they decide to take them over when the present lease of the Company expires in 1900.

Burton-on-Trent.—At the last council meeting Messrs. Slater & Co., of Darlaston, made an application for power to lay down tramways in the borough, and the letter was referred to the borough surveyor for a report thereon.

Central London Railway.—The first junction of the tunnels between Holland Park and Notting Hill Gate stations was successfully made on Saturday night. The following junctions will be made before the end of the current year, viz., Shepherd's Bush station and Woodhouse Park (the generating station), Shepherd's Bush and Holland Park stations, and Queen's Road and Westbourne stations, and in February, 1898, the last junction of No. 1, 2, and 3 contracts will be made between Notting Hill Gate and Queen's Road stations.

Dundee.—At the meeting of the Special Tramways Committee on 16th inst., Messrs. Urquhart & Small, consulting engineers, were in attendance and submitted a preliminary report upon the inspection of the routes of the proposed tramway extensions, and the question of motive power and power stations for same. They had no hesitation in recommending the overhead trolley system, with power station at about the middle of the system. Questions were put as to the probable expenditure upon the proposed extensions, in reply to which the engineers stated that they were not yet in a position to give such information. The committee instructed them to frame an estimate of the cost of the necessary buildings at the power station, and of the engines, boilers, dynamos, standards, cars, and other apparatus applicable to all the existing tramways and the proposed extensions, and to submit a report. The burgh engineer received instructions to estimate the cost of altering the guage of the existing lines to four feet, and also the cost of dealing with properties which might stand in the way of the widening of several of the thoroughfares through which the lines will pass. These reports when submitted will be considered at another meeting of the committee.

Germany.—The horse tramways in Frankfort-on-Main, which were owned by a Belgian Company, have been taken over by the municipality. They are to be converted into electric lines, the contract having been divided between Messrs. Siemens & Halske, of Berlin, and Messrs. Brown, Boveri & Co., of Baden, Switzerland.

Glasgow.—In a note last week we recorded the decision of the Corporation on the proposed amalgamation of the Electricity and Tramways Committees. We stated that the proposal was rejected, and we now learn that there was only a majority of one vote. The matter was discussed very exhaustively by the members of the Corporation. Mr. Maclay, of the Electricity Committee, opened the debate, and said that his committee opposed the union for a variety of reasons. They quite agreed that it would be the right thing that the generating and distributing of the current should be in the hands of one committee, and that for all purposes. But they went further,

and thought that that committee should be the Committee on Electricity. Another reason was, they had a conviction that they were perfectly able to manage this business. If they had only been trusted as other committees of the Council had been, they would have gone on to erect new works on the north and south sides of the river; and they believed that they would have been able in a very short time to supply the electric current for all purposes to the entire city at the lowest rate obtainable in any town or city in the three kingdoms. If the business of the Electricity Committee were well managed, there could not possibly be a loss. But, supposing that the Electricity Committee needed to go somewhere else for advice and assistance in the management of their business, was it fair for the Council to ask them to go to the Tramways Committee? Up till this point the Tramways Committee had been without any experience whatever of the management of the electricity department. The Electricity Committee, on the other hand, had had five or six years' experience. Mr. Paterson, in seconding, said the chief attraction of his Lordship's proposal was that of the economy it held out. But the matter of economy was one that the Electrical Committee doubted, and with good reason. He thought that if they gave the electric production for all purposes into the hands of the Electric Committee, that body were quite ready to appoint an expert who could undertake all the public electrical work of the city. Mr. Primrose moved that the Lord Provost's scheme of amalgamation be adopted. It would be absurd to have had two committees working on the same lines, when they might have been working harmoniously as one dealing with lighting as well as motive power. The proposed amalgamation did not mean superseding the Electric Committee any more than it meant superseding the Tramway Committee. Bailie Alexander seconded the amendment. It was almost essential that the Tramway Committee should have control of their motive power. Various other speeches were made, and the Mr. Maclay's motion was rejected, the voting being 25 for and 26 against. The Council were discussing a a minute of the Electric Committee, an amendment by Dr. Colquhoun referring it back to enable the committee to report on the advisability of supplying electricity on the high tension system being before the meeting, when the debate was adjourned until Monday. The discussion was resumed on that day. Dr. Carswell seconded the amendment. He said that they were in a critical position as regarded the electricity question; it was the Electricity Committee who were to face the question, and they had not yet told the Town Council all they knew, or were supposed to know. The question of high and low tension must be faced. Mr. Paton supported the recommendation of the Electricity Committee. He argued that the low tension system up to 700 volts was a right thing, and that the high tension system up to 1,500 volts was also a good thing, and that the union of the two systems produced the best results. There was no doubt that all experts in this country were agreed on that point. He said emphatically that the Committee were right in their recommendation. Mr. Maclay, in closing the debate, said the low tension system from the proposed stations would supply the whole of the city from Maryhill and Springburn to Pollokshaws, and from Parkhead to Kelvinside. If a supply were wanted for further outlying districts it could be sent out on the continuous current system. Their proposals would enable the leading thoroughfares to be lighted with electricity. The voting was 37 for the minute, and 16 for the amendment.

Huddersfield.—The Corporation has adopted the recommendation of the Tramways Committee that application be made for a provisional order authorising the Corporation to construct and work new tramways from the Salendine Nook terminus to the Globe Inn, Outlane; from the terminus at the top of Paddock to Quarmby Mill, Longwood.

Motor Car Matters.—The *Daily News* Paris correspondent says that M. Delpuech, the Postmaster-General, is preparing a Bill for the gradual adoption of motor cars and omnibuses by the Post Office. The cars are to be of lightish build. It appears that the question of the weight of motor cars is being studied by the Streets and Thoroughfares Department, at the Hôtel de Ville. The object is to prevent such cars running as would soon wear out wooden and asphalte pavement by crushing them down.

On Saturday last some trials were made by Messrs. J. & C. Stirling, motor car builders, of Hamilton. A motor car of recent type was run a distance of 100 miles on the Carlisle Road with the view of ascertaining among other data the actual cost of such a journey. The amount of fuel consumed was found to be exactly five gallons, which, at the present cost of 11d. per gallon, and with the lubricating oil used, made the total cost for 100 miles 4s. 10d. Three passengers were carried and about a hundredweight of baggage, making the net cost per passenger 1s. 8d. for the journey. The time for the entire journey was about 8½ hours, including stoppages.

St. Helens.—The chairman of the St. Helens and District Tramways Company addressing the shareholders on 16th inst., made a few remarks on the question of motive power. "They knew exactly," he said, "where they were now with the steam power they were using. They were thinking with the Corporation of changing their motive power from steam to electricity, and in that matter the directors hoped to make a fair and reasonable bargain that would improve the position of the company. If they adopted any new system of working, he said let it be by electricity and nothing else, and by electricity they hoped to improve their position. Since their last meeting the directors had had an offer to purchase the company out at par. That was certainly an improvement that he rejoiced to be able to announce, but although the shares had advanced by that offer to par, the directors had not seen their way to accept it, as the majority of them thought that the shares were worth far more money. They had had difficulties to contend with, and they thought they were now on velvet, and wanted to remain in that happy position."

TELEGRAPH AND TELEPHONE NOTES.

Breaking Telegraph Insulators.—It is with considerable satisfaction that we notice that many of the youthful offenders who wantonly do so much damage to the telegraph insulators throughout the country are being brought to justice. A lad guilty of using these as targets for stone throwing at Leicester has been fined 15s. These offences cost the Postal authorities a nice little sum one way and another in the course of a year, and they should be put down with a strong hand.

Is this Irony?—The *Leeds Mercury* writes as follows: "'Wireless' telegraphy is to be tried as a means of connecting Sark with Guernsey. The smaller island has been deprived of a cable for so long because, the sea being very rough and the bed extremely rocky, the cost of repairs would be out of all proportion to the telegraphic business likely to come to the Post Office. It is said that a Rothschild syndicate has acquired the British interests in Signor Marconi's invention, and that some public demonstrations are to be organised this winter. The Italian seems to have been successful in getting himself noticed all over the world; but months ago our own Mr. Preece, the electrician to the Post Office, secured results on the coast quite as wonderful as anything which has been put to the credit of Signor Marconi. The Englishman being a modest man, read a little paper about his experiments before one of the technical societies, and only got a paragraph here and there. The Italian made a splash at Rome under the eye of his King, and the facts were wired all over the world, and printed in big type."

Prof. Milne on Seismic Disturbances.—Prof. John Milne, writing from Newport, Isle of Wight, to the *Times*, says:—"Whilst at the British Association meeting in Toronto on several occasions I exhibited a seismogram which had been forwarded by post from my station in the Isle of Wight. This was the record of a large earthquake, the duration of which had been three hours. From the general character of the diagram, and because the preliminary tremors had a duration of 30 minutes, I suggested that the centre of the disturbance had been in or near Japan, and, if so, it had originated there on August 5th, at about 9 hours 6 minutes a.m. Up to August 26th, when I left Toronto, no news of such an earthquake was received. I now find by mail advices dated New York, August 30th, that in Japan there was an earthquake and tidal wave, accompanied by loss of life, on August 5th and 6th; whilst Captain H. J. Snow, of Yokohama, in a letter dated August 5th, says: 'Whilst I am writing a heavy, slow earthquake is going on. It is now 9 hours 14 minutes a.m.' The character of the motion felt by Captain Snow indicates that Yokohama was at a considerable distance (possibly 600 miles) from its origin, and, therefore, the time at which the earthquake took place was at least five minutes earlier than that noted by Captain Snow. The conclusion to be deduced from these facts is that the Isle of Wight record refers to the earthquake in Japan, and that we have here another of the many instances where instruments which record the unfelt movements of the earth's crust have given us information long before we receive it through ordinary sources. When we remember that seismic action is from time to time directly connected with the interruption of cables, which interruptions have been regarded as operations of war and resulted in the calling out of naval and military reserves, as was the case in Australia in 1888, it is difficult to understand why all countries, and especially our colonies, have not yet provided themselves with instruments the records from which yield information of public interest and which may often be the means to dispel unnecessary excitement and alarm." The Australian instance of the calling out of the reserves in 1888 was referred to by us in an article on "Submarine Cables in War Time," which appeared in the Electrical Review for July 3rd, 1896.

Telegraph Clerks' Grievances.—The Duke of Norfolk has addressed a letter, through his secretary, to Mr. A. Newton, of the Postal Telegraph Clerks' Association, in which he says: "The various assertions which you mention as having been made respecting the pay, conditions of service, &c., of telegraphists in the employment of this department, are not in accordance with the facts." Proceeding, says Monday's *Daily News*, the Postmaster-General refers to a number of concessions, stating that the maximum pay of the operators has not been reduced, but on the contrary has been increased to £160. With reference to the alleged £190 maximum, it is stated that this is only paid to those men who are classed as senior telegraphists. Dealing with the question of overtime, the Duke of Norfolk states that when the exigencies of public service necessitate a longer regular attendance than eight hours upon any one day, the officer's attendance on the following day is correspondingly decreased, so that the whole attendance is limited to 16 hours in 2 days. The letter confutes the contention that the department is under any contract with the telegraphists, and says that "the position is simply this—the telegraphist is employed during the pleasure of the Postmaster-General, and if he does not do what is required of him that pleasure may cease, and with it the employment." The London Executive of the Postal Telegraph Clerks' Association has decided to employ the services of counsel to determine the legality of the statements contained in the letter. They claim that the contention that "telegraphists are not engaged under any kind of contract" is a denial of their rights and privileges as citizens, and is intended to place them in an inferior position to those employed in other branches of the Civil Service. The implied threat contained in his statement that "if he does not do what is required of him that pleasure may cease, and with it the employment," has occasioned less comment than the denial that there is any sort of contract between the Post Office and the telegraphists. The men claim that a paper was handed to them on entering the service and which distinctly

states that they shall have a prospect of rising to £90 a year. If this is not a contract, the men ask, what else it is? They claim further that the contract has long been recognised not only in the Post Office, but throughout all branches of the Civil Service. The Fawcett Association has received information that Mr. Swift, editor of *The Post* (the official organ of the Association), has been removed from his acting overseership. The Executive of the Association has adopted the following resolution, which has been forwarded to Sir Albert Rollit: "That we, the Central Committee of the Fawcett Association, hereby tender our hearty sympathy with the officer who has been removed from the acting overseers' staff; and, remembering his work has always been done well, we consider that the attack cannot be dissociated from his position as an officer of this association, and we hereby request Sir Albert Rollit to lay it before the Duke of Norfolk."

Telegraphic Interruptions and Repairs:—

Cables.	Down.	Repaired.
Brest-St. Pierre (Anglo, 1869)	April 6th, 1893 ...	...
West Indies—		
St. Croix-Trinidad ...	Nov. 30th, 1896 ...	...
Amazon Company's cable—		
Parintins-Itacatiara ...	May 5th, 1896 ...	...
Obidos-Parintins ...	Dec. 7th, 1896 ...	...
Cyprus-Latakia	July 23rd, 1897 ...	...
St. Vincent-Santiago... ...	Sept. 2nd, 1897 ...	Sept. 16th, 1897.
Mozambique-Lourenco Marquez	Sept. 4th, 1897 ...	Sept. 22nd, 1897.
Bolama-Bissao	Sept. 13th, 1897 ...	...
Landlines.		
Trans-Continental line beyond Masol	March 12th, 1896 ...	...
Carthagena - Barranquilla (Columbia)	July 4th, 1896 ...	...
Siberian landlines—		
Blagowestchensk-Khabarowka	Sept. 12th, 1897 ...	Sept. 17th, 1897.
Saigon-Bangkok	Sept. 14th, 1897 ...	Sept. 15th, 1897.
Guatemala landlines interrupted to Quezaltenango, Retalhulen, Ocos, Candelaria, Pouvenire, and all places West of Antigua	Sept. 17th, 1897 ...	
Nicaragua landlines	Sept. 21st, 1897 ...	

April 19th, 1897.—During war between Turkey and Greece, cable between Trieste and Corfu cannot be used for messages for Turkey; they must be sent *vid* Bosnia, Montenegro and Servia.

The Ottoman Government announces that messages in secret languages may not be sent to the Greek Minister and Consul in Turkey. They are to be sent in plain language.

April 21st, 1897. — The Greek Administration prohibits secret language for private telegrams for Greece.

April 25th, 1897.—The Hellenic Administration notifies delay on press messages emanating from Greek provinces by reason of the lines being blocked.

April 26th, 1897.—The Ottoman Administration notifies that, until further notice, private telegrams for Crete must be written only in plain Turkish or French language.

September 3rd.—Eastern Company announce that traffic for South and East Africa is subject to serious delay.

September 12th.—All telegrams for Guatemala are subject to censure at San José.

September 17th.—Telegrams for Guatemala can only be accepted at senders risk.

September 20th.—Traffic for South Africa is not subject to any more delay.

September 21st.—Telegrams for places beyond San Juan del Sur are subject to delay.

The Commissioners of Sewers and Telephone Matters.—At the Commissioners of Sewers on Tuesday, the dispute between the Postmaster-General and the Commissioners with regard to the laying of telephone tubes came up again in the shape of a formal notice from the Postmaster-General requiring the consent of the Commissioners to the placing and maintaining of a line or lines of underground telegraphs in or under certain streets in the City, and intimating that, failing such consent, a difference would be deemed to have arisen between the Postmaster-General and the Commission within the meaning of Section 3 of the Telegraph Act, 1878. The Postmaster-General further stated that he would apply to the Tribunal having jurisdiction in that behalf within the district if the consent of the Commissioners was not forthcoming within a certain period. Captain Hall reminded the court how necessary it was that the proper persons should decide so important a point. The point in dispute was that the Post Office authorities wished to lay telephone tubes, which they let out to other people. He moved that the letter should be referred to the Streets Committee. Mr. Hudson, in seconding the motion, said he did not think there was any likelihood of the Commission being unpleasantly treated by the authorities. Mr. Barham said the real point at issue was the effort on the part of the Commission to obtain a cheaper telephone service. The Chairman reminded Mr. Barham that that question scarcely arose out of the present motion. It was, indeed, quite a different matter. The letter was referred to the Streets Committee to report upon. The Clerk read a letter from Mr. A. C. Morton enclosing a communication from the Town Clerk of Glasgow, who expressed a wish that a member of the Commission of Sewers would attend and give evidence at an inquiry to be held on the 28th inst. in respect to the telephone service in London. Mr. Morton explained that he was unable to attend the meeting of the court that day, and suggested that the Commission should do all in its power to assist the Glasgow people in their efforts to obtain a cheaper telephone service. Captain Hall moved that Mr. Morton should be asked to attend as a witness at the inquiry in question, as, he said, that gentleman knew as much about the question as any one. The Commission of Sewers would be, therefore, ably represented. Mr. Berridge seconded the resolution. It was then adopted.

CONTRACTS OPEN AND CLOSED.

OPEN.

Belize, British Honduras.—October 20th. The District Board of Belize invite tenders for the lighting of the town by electricity. System proposed, "three wire or neutral wire," comprising boilers, engines, dynamos, accumulators, mains, &c. Particulars from Mr. A. R. M. Simkins, M.I.E.E., care of F. Otto, Esq., Tower Chambers, Moorgate Street, E.C. See "Official Notices," September 17th.

Bray.—September 27th. Tenders are being invited by the Township Commissioners for the supply of 15 alternating current arc lamps, globes and carriers. See last week's "Official Notices."

Denmark.—October 1st. The Electric Lighting Committee of the Copenhagen City Council is inviting tenders for the supply and erection of an electric lift together with the necessary electro-motor. Tenders to the Belysningsdirektørens Kontor, Vestre Boulevard, 22, Copenhagen.

France.—September 30th. Tenders are being invited by the French Minister of Commerce for the concession and working of an electric tramway in the grounds on the left bank of the Seine, of the 1900 Exhibition, during the period the exhibition is open. The line is to be about 4½ kilometres, and is to be ready for operation by January 15th, 1900. Particulars of the scheme may be had from the Ministère du Commerce, Paris.

Glasgow.—October 20th. The Corporation want tenders for the electrical equipment of the Springburn and Mitchell Street route. Specification and particulars from Mr. John Young, general manager, 88, Renfield Street, Glasgow. See our "Official Notices" for further details.

Hull.—November 5th. The Corporation invite tenders for the electrical equipment of their tramways, to the extent of about 9 miles double track and ½ mile single track. The contract will not be divided and will include engines and generators, switchboards, feeders, poles, brackets, trolley wire, rail bonding and all accessories, also the first instalment of cars (15 motor cars and 5 trailers). City engineer, Mr. A. E. White. City electrical engineer, Mr. A. S. Barnard. See our "Official Notices" last week.

Italy.—September 28th. The Direzione Generale delle Ferrorie Meridionali, of Florence, are inviting tenders until the 28th inst. for the supply and erection of a 40-ton electric crane. Tenders to above.

Plymouth.—October 2nd. Tenders are invited by the Corporation for overhead trolley line posts, brackets, tramcars, trucks, motors, trolley arms, &c., in connection with the borough electric tramways which are to be laid down. Borough electrical engineer, Mr. J. H. Rider. See our "Official Notices" last week.

Queensland (Aus.).—November 15th. The Municipal Council of Ipswich, Queensland, is inviting tenders for the supply and erection of the following electric lighting plant, &c.:—Tubular boilers, pipes, pumps and heaters, alternators and exciters, switchboard, high and low tension mains, junction boxes, transformers, &c. Specifications, and all particulars as to conditions, &c., may be obtained from Messrs. Gordon & Gotch, St. Bride Street, Ludgate Circus, London, E.C., and tenders have to be forwarded to the Town Clerk (Mr. Albion Hayne), Council Chambers, Ipswich, Queensland. See last week's "Official Notices."

Roumania.—November 15th. Tenders are being invited by the Municipal Authorities of Ploesti, for the concession for the establishment and working of an electricity generating station in the town, during a period of 40 years for private and public lighting and also for power transmission purposes.

Russia.—September 30th. Tenders are being invited by the Municipal Authorities of Penza for the concession for the construction and working of a system of tramways in the town, to be worked either by electricity or other mechanical power.

Russia.—November 1st. The Municipal Authorities of Novorossisk, South Russia, are inviting tenders for the concession for the construction and working of an electric tramway and for the electric lighting of the town.

Spain.—Tenders are at present being invited by the Municipal Authorities of Laredo (Santander province) for the concession for the electric lighting of the town during a period of 15 years. Tenders to be sent to El Secretario del Ayuntamienta de Laredo (Santander).

Spain.—Tenders have just been invited for the concession for the electric lighting of the public streets of Placencia (Guipuzcoa province) during a period of three years.

Southampton.—October 18th. The Corporation invite tenders for the supply and erection of engines and alternators, motor alternator, rectifiers and switchboards for high tension, engines and continuous current generators, balancing and volt-raising transformers

and switchboard for low tension; accumulators and accessories. Consulting engineers, Messrs. Kincaid, Waller & Manville. See our "Official Notices" for further particulars.

Wakefield.—October 2nd. The Corporation want tenders for the electric light wiring of the Town Hall. Particulars at the Town Clerk's office. See our "Official Notices."

CLOSED.

Brighton.—The Town Council have accepted the tender of Messrs. C. G. Reed & Son, of Brighton, for the erection of an iron platform with glass floor to form a switch board gallery in the engine room at the electricity generating station, the price quoted being £125 against £151 10s. quoted by Messrs. L. Ward, Bros. & Eckstein, London.

France.—The French Post and Telegraph Authorities have just placed a contract with the Société Industrielle des Telephones, of Paris, for 200 kilometres of submarine cable in two lots, and with Messrs. Husson, Thevignot & Co., of Closmortier, near St. Dizier, for 20 tons of iron wire 2 mm. in diameter and 80 tons of iron wire 7 mm. in diameter.

Germany.—A contract for the erection of a central station at Baden Baden has now been definitely placed with Messrs. Siemens & Halske of Berlin. The station has to be completed by May next.

Newport.—The Electricity Committee last week reported upon tenders which had been received for the premises and plant required for the extension of the electric lighting undertaking. The tender of Mr. David W. Richards at £6,400 for the erection of buildings was accepted. The plant for the extension was divided into various sections, the total amounting to £15,272, and contracts were given out to:

	£
Edwin Danks & Co., Birmingham	2,445
J. Fowler & Co., Leeds	11,354
Electric Construction Co.	880
Siemens Bros.	593

Huddersfield.—The list of tenders sent in for the electric wiring and fitting of the Union Offices, Ramsden Street, for the Guardians is as follows:—

	£	s.	d.
Martin, Smith & Co.	118	0	0
J. H. Taylor & Co.	84	18	0
T. W. Broadbent	87	0	0
Fellows, Wheatcroft & Co.	189	5	6
A. Sykes	89	10	0
Fowler, Lancaster & Co.	178	0	0
C. Walkers	133	16	0
Read Holliday & Sons (accepted)	61	18	3

Paisley.—At the last meeting of the Electric Lighting Committee, the offer of Messrs. A. Green & Son, Limited, to supply an engine for the economiser at £25 was accepted, also the offer of Messrs. Hanna, Donald & Wilson to supply cast-iron water tanks at £77.

Yarmouth.—The contract for coal for the electric generating station has been given to Messrs. Bateman at 14s. per ton.

NOTES.

Street Lighting in the City.—No one can accuse the City Commissioners of making haste too quickly in the improvement they have long intended to effect in the lighting of the side and narrow thoroughfares of the City of London. Experiments were made with incandescent electric and arc lamps in some parts at the instructions of the Commissioners, with what results has not yet been made public. We suppose Mr. Voysey's report is by this time in the hands of his committee, though until that committee has gone into the matter exhaustively and settled the nature of its recommendations, the Commissioners will not have the question under serious consideration. At last Tuesday's meeting Mr. Greenwood asked whether any decision had been come to with reference to the lighting of the minor streets of the City by electricity. Captain Hall replied that the committee were still considering the question, and would come to a decision as soon as it was possible.

Search Lights for Coast Defence.—We understand from the daily papers, that on the 17th inst. experiments were conducted with the electric search lights installed at Sheerness in connection with the scheme for the defence of the entrances to the Rivers Thames and Medway. Two lights were brought into operation, one being installed close to No. 1 bastion, and the other on the esplanade. Passing vessels were easily distinguished.

The Rheinfelden Hydro-Electric Installation.—Some time ago we gave a few particulars of this power plant, as set forth in a paper by Mr. Rothenau before the Verband Elektrotechniker, of Germany, the author entering very fully into all the details of what was then only a scheme or proposal. The actual work is, however, well in hand now, and the Continental electrical papers are beginning to publish photographs and views of the progress made from time to time. It will be remembered that so long ago as 1889 a company was formed for the purpose of making use, in what should be considered the most desirable way, of the fall in the river Rhone at or near Rheinfelden, the idea being to erect a power house with turbines, dynamo generators, &c., and transmit electric energy for lighting and power purposes to adjoining centres of distribution. The works finally decided upon were begun in 1895, and it is expected that they will be completed by the end of the present year. They involve the construction of a dam across the river, leaving a passage of some 75 feet in width for navigation; also of a canal or head race along the bank of the river, with a width of 165 feet, and a length of 1 kilometre, a massive stone wall separating the canal from the river; and lastly, of the turbine and dynamo house, with a short tail race through which the water passes back to the river. This latter is excavated out of rock. The available fall of water varies from 21 to 24 or 25 feet in a distance of a mile and a half, and an average volume of water, equal to 12,360 cubic feet per second, passes down. Twenty double turbines are installed, each designed to give 840 H.P. at a speed of 55 revolutions, and with a 13-foot fall. They are of the reaction type, and are mounted vertically, so as to drive the dynamo generators direct, in a similar fashion to that adopted at Niagara. The exact details of the electric distribution system do not appear as yet to be finally settled; but the author states that the electric reduction works in the neighbourhood will be supplied with continuous current, and other customers for power with low tension three-phase current, suitable for electric furnaces. For the three-phase service, a periodicity of 50 per second is decided upon, with a difference of potential of 3,900 volts per phase. This tension will be transformed up to 16,500 volts between conductors, for distances over 12 miles. The continuous current machines are provided with 32 poles set round the interior of a ring, with an inner rotating armature ring. They are capable of an output of 560 kilowatts, and number 10 in all, of which six 70-volt machines are to supply current for the Neuhausen Aluminium Works, and the other four give current at 150 volts to the Bitterfeld Chemical Works. The distribution is effected by overhead cables on porcelain insulators fastened to wooden poles set, on the average, 130 feet apart, with lightning arresters every quarter of a mile or so. Sub-stations will supply low tension current for lighting and motors of less capacity than 4 H.P., at 120 volts; larger motors will be run on 500-volt power circuits. The price of electricity thus supplied is settled at 5d. per unit for lighting, with discounts ranging from 5 to 80 per cent. for periods of use varying similarly from 500 to 6,000 hours per annum. For power purposes current will be sold at ·8 of a penny per unit, or else at one-fifth of a penny per unit plus a fixed payment varying from £8 to £2 12s. 6d. per annum per kilowatt installed.

Fatality through Negligence.—An inquest was held last week, at Deptford, on the body of John Smith, aged 26, who was in the employ of the Charing Cross and Strand Electricity Supply Corporation, Limited, Commercial Road, Lambeth. On returning home on the 1st inst., Smith complained of having hurt his left knee and right hip by an accident at the works, and he subsequently succumbed to his injuries. On inquiry being made at the works, it was found that he had fallen into an opening of just over 2 feet deep, a floor plate having been removed. Mr. Wm. H. Patchell, engineer-in-chief at the company's works, said the man who removed the plate should have put it back again. The jury returned a verdict of death from pressure of blood on the brain following a fall into a pit, caused by the negligence of the Charing Cross and Strand Electricity Supply Corporation, Limited, in allowing a floor plate of a pit to be shifted out of its place, and to be left unguarded. Mr. C. B. Pendock, Inspector of Factories, was present at the proceedings.

From the Wild and Woolly West.—Every now and then we read in the American papers of some enterprising motor man who thinks that trolley cars can swim, and makes no scruple about running over an open drawbridge. It need hardly be remarked that these bridges are always provided with danger signals to show (at a distance amply sufficient to stop a car) whether they are open or not; and as a general rule it is laid down that all cars must stop dead within, say, 200 feet of a drawbridge whether the latter be open or not, the conductor then going forward and giving the word when it is safe to pass on. Sheer recklessness and criminal neglect must, therefore, have been the cause for a motor man recently running his car over a straight and level approach, 500 yards long, to a drawbridge over the Saginaw river, in Michigan, plunging right into the open draw at a speed of 20 miles an hour, in broad daylight, and without making the orthodox stop prescribed by the law. The forward end of the car reached a point in the bed of the river nearly 75 feet distant horizontally from the edge of fixed span where it jumped off the rails—so that the speed must have been at least that above stated. Out of 13 persons in the car (surely an unlucky number this time!) six were drowned, one was fatally injured, and the others all more or less seriously. The report does not, unfortunately, state whether the motor-man was killed or not; but the curious point about such incidents is that those at fault appear to be quite ready to take their chances along with the other victims, and the death of one motor-man would probably not deter others from equal carelessness. In this case he seems to have lost his life, as no definite reason is assigned for his behaviour beyond the statement that he was racing a steam train on parallel tracks, and in consequence did not keep a look-out ahead. The same page of the *Street Railway Review* that describes and illustrates this incident, also contains an item to the effect that the general manager of the West Chicago lines has offered a large reward for the discovery and arrest of the men who stopped cars recently on his system, and robbed the passengers. It sounds rather mediæval, or let us say "Deadwood coachy," to read of highwaymen in Twelfth, Sixteenth, and Forty-second Streets of a city that aspires to the position of metropolis in the West; and it is also a pungent criticism upon the defective police control of the place.

American Electric Motor Cars.—A correspondent writes:—"With the exception of a few vehicles of the fancy type, made by the Pope Manufacturing Company and one or two others, electric automobile practice in the United States is heavier than with us, the battery is weightier, and the cabs do not run so far with a single charge; the construction, however, appears good, and the batteries made by the E S.B. Company with 'Manchester' positives and 'chloride' negatives, are mechanically strong, and cannot well be costly in maintenance. The simple 'chloride' battery used for the very light vehicles is avowedly costly, as the positive pole electrode pellets disintegrate almost as soon as they are properly peroxidised through, which would be after about three months' hard work. However, the Pope Manufacturing Company take this type in preference, as the carriage and equipment are all very light, a high speed electro-motor weighing only 75 lbs. being used. The future of electric cabs in the States, in towns such as Philadelphia, is certainly a great one; but what success they will achieve on the terrible roads of New York City appears to be highly problematical."

Workmen's Compensation.—A small hand-book to the Workmen's Compensation Act, of 1897, by M. Robert Jones, is now in its second edition. It is published by the *Western Mail*, and dedicated to the present Colonial Secretary, and as it goes very exhaustively into the Act, and into the various interpretations which have been placed upon some of its clauses by such authorities as the Lord Chancellor, Lord Herschell, Mr. Asquith, Mr. Chamberlain, and the Home Secretary, it should be in every employer's possession, as well as on the bookshelf of employés. For a master to be unacquainted with the provisions of this enactment might happen at some time or other to lead to complications of an unpleasant, and probably serious nature in his business; and, on the other hand, the workman should, if possible, be clear as to the circumstances under which he can or cannot claim compensation, and the extent thereof, if any.

Accumulators in Central Stations.—A German contemporary recently published in a tabulated form particulars of German central stations, from which it appears that 80 per cent. of the continuous current stations in that country are provided with accumulators, the total output of which is 31 per cent. of the whole power of these stations. Notwithstanding such figures as these, says the *Electrical World*, there are many American electrical engineers who still doubt the advisability of installing accumulators in connection with central stations.

Electro-Chemistry.—A special course of instruction in electro-chemistry will be given during the coming season at the City and Guilds Central Technical College. The course will include practical instruction in electro-deposition, the use of the electric furnace, dynamos, transformers and accumulators. A great part of the time of students attending this course will be devoted to electro-chemical research and the study of electro-chemical action. Candidates for admission will be required to submit evidence of having a general knowledge of physics and chemistry, and of having been specially trained in one of these subjects.

A Royal Electrician.—According to the *Daily News*, Signor Giarelli, who is well acquainted with the Italian Court, describing the character of the Prince of Naples, says that "his hobbies are of a scientific nature. He is, perhaps, the only real electrician among all the present princes of Europe. He has never occupied himself much with literature, music, or painting, but he is a master of electric mechanism. He is very learned in all that concerns the application of electricity to light, motive power, sound, and photography. He was one of the first and most successful experimenters with the X rays after their discovery, and in Rome his residence in the Quirinal had the aspect, during his Royal Highness's bachelor days, of a scientific laboratory."

Forthcoming Book.—Mr. W. Perren Maycock has in the press, to be published in a few weeks, a new book, entitled, "The Electric Wiring and Fitting Details Book." It is intended to afford a convenient means for noting down all details concerning any proposed or intended installation of the electric current in any buildings. The publisher is Mr. Reginald Flint, 18, Bride Lane, New Bridge Street, London, E.C.

Petroleum Autocars.—On Thursday morning last week, about 12.30, an autocart belonging to Messrs. Burroughs and Watts burst into flames while in Finsbury Circus; it was run into East Street, and after some 20 minutes' work with water and a soaked rug, the fire was extinguished. A large circle of spectators surrounded the cart, and many lent assistance. It is appalling to consider what must have been the result had the petroleum spirit container exploded under these circumstances.

Electric Cab Fatality.—A boy eight years of age was hanging behind one of the Electrical Cab Company's cabs at Hackney on Wednesday, when it is supposed his clothing became entangled with the chain wheel, and he was crushed to death. Of course many people will blame the cab and not the boy, and declare that motor cabs are highly dangerous. We may expect our apprehensive "growler" to make good use of the sad affair.

General Post Office.—The following appointments have been made in the Engineer-in-Chief's Office:—Mr. J. Gavey, Assistant Engineer-in-Chief; Mr. M. Cooper, Superintending Engineer; Mr. H. R. Kempe, First Class Technical Officer; Mr. P. Ennis, First Class Technical Officer; Mr. W. Brown, Assistant Superintending Engineer.

Electrolysed Sea-Water.—An *Indian Engineering* telegram says that the experiment of the Bombay Corporation as to the utility of the electrolysed sea-water for cleansing sewers is, so far as can be seen at present, unfavourable; not only as regards the effect, but also in respect to cost.

Appointment Vacant.—Burnley Council want an assistant electrical engineer and manager, at £2 per week. See our "Official Notices."

The Measurement of the Capacity of Polarisation.—An interesting communication has been made by C. M. Gordon to the *Annalen der Physik und Chemie*, respecting the formulæ used in measuring the capacity of polarisation. From a number of observations which he has made, it seems clear that the Kohlrausch formula does not always hold, though it is accurate enough in some cases. The discrepancies are carefully discussed in the *Annalen*, *vide* 1897 (ii.), No. 61, pages 1—29, but the essence of the communication will be sufficient for our purpose, and is as follows:—For small currents polarisation is a reversible process, and if E is the force which it sets up, c the capacity, j the current, and t the time, the Kohlrausch formula $E = 1/c\ f\ j\ d\ t$ holds; if, however, the current is increased beyond a certain value, the capacity does not remain constant, and the formula no longer applies. When mercury electrodes are used, the capacity depends primarily on the number of dissolved mercury ions in the solution. The capacity in the case of platinum electrodes depends both on the quantity of occluded hydrogen or oxygen, and on the concentration of the electrolytes. Resistances can be accurately determined with platinised platinum electrodes, but the values obtained are too great when the electrodes are not platinised.

Correction.—In Mr. Lyell's article on Dr. de Laval's turbine and boiler, on page 374 of our last issue, a clerical error occurred. In the last line but one, for *33,000* watts, read *66,000* watts.

Salford Science Students' Association.—At a meeting of this Association on October 2nd, a paper will be read on "Engines for Electric Lighting Purposes," by Mr. J. Davidson.

King's College.—We have before us a copy of the syllabus of the day and evening classes in architecture, building construction, and modern practice, for the 1897-8 session at King's College.

Ceylon Appointment Vacant.—An instructor in electrical engineering and telegraphy is required for the Technical College at Ceylon. For particulars as to qualification, salary, conditions, &c., see our "Official Notices."

NEW COMPANIES REGISTERED.

Shaw, Peacock & Company, Limited (3,600).—Registered in Edinburgh on September 10th, 1897, with capital £1,000, in £2 shares, to carry on the business of manufacturers and repairers of bicycles, &c., and the business of mechanical and electrical engineers. The subscribers are: W. Oliver, Bridge Street, Hawick, solicitor, 10 shares; J. G. Shaw, 19, Havelock Street, Hawick, cycle engineer, 10 shares; D. Oliver, Thornwood, Hawick, auctioneer, one share; W. B. Sime, 4, Eckdaill Terrace, Hawick, manufacturer, 10 shares; J. W. Glenny, Bucklands, Hawick, manufacturer, one share; S. H. Wilson, Deanfield, Hawick, manufacturer, 10 shares; C. J. Glenny, Bucklands, Hawick, manufacturer, 10 shares. Registered by Steadman & Ramage, agents for the company, 37, Castle Street, Edinburgh. The first directors are S. H. Wilson, D. Oliver, J. W. Glenny, W. B. Sime, J. G. Shaw; qualification, five shares.

Heath, Tizzard & Co., Limited (54,045).—Registered September 11th with capital £2,000, in £1 shares, to acquire and carry on the business of electrical engineers carried on by G. Heath and J. Tizzard at 105 and 107, Broad Street, Hanley, Staffs., and to adopt a certain agreement. The subscribers (with one share each) are:—G. T. Heath, Burslem, Staffs., engineer; J. Tizzard, Hanley, Staffs., electrical engineer; R. Pepper, Hanley, Staffs., electrician; W. Mellor, Burslem, Staffs., surveyor; A. Heath, Burslem, Staffs., agent; F. Bedson, Hanley, licensed victualler; F. W. Harris, Burslem, solicitor. The number of directors is not to be less than three nor more than five; the first are G. T. Heath, J. Tizzard and R. Pepper. Qualification £5; remuneration as fixed by the company. Registered office, Broad Street, Hanley, Staffs.

John Haynes Lighting Co., Limited (54,054).—Registered September 14th, with capital £2,000, in £100 shares, to carry on the business of electrical and mechanical engineers, and manufacturers of, and dealers in, electric, magnetic, telegraphic, telephonic, and other appliances and apparatus. The subscribers (with one share each) are: T. H. W. Walker, 41, North John Street, Liverpool, surveyor; E. Totty, 42, Castle Street, Liverpool, printer; G. F. Ransome, 67, Tithebarn Street, Liverpool, engineer; H. Isaac, 24, Bedford Street, Liverpool, fish merchant; P. Walker, 64, Duke Street, Liverpool, wine merchant; I. C. Glover, Fontenoy Street Brewery, Liverpool, brewer; R. F. Atkinson, Athenæum, Liverpool, architect. The number of directors is not to be less than three, nor more than seven. The first are T. H. W. Walker, E. Totty, R. F. Atkinson, H. Isaac, G. F. Ransome, I. C. Glover, and L. Hughes. Qualification, £100; remuneration as fixed by the company. Registered by Lydall & Sons, 37, John Street, Bedford Row, W.C.

Tudor Accumulator Company, Limited (54,080).—Registered September 16th with capital £50,000, in 3,000 "A" and 1,200 "B" shares of £10 each, to acquire the business of an electrical engineer and manufacturer of accumulators carried on by A. B. Pescatore at 5, Cross Street, Manchester, and at the Barn Meadow Works, Dukenfield, to acquire certain patents of H. O. Tudor, and to enter into a certain agreement. The subscribers (with one share each) are:—L. Cellerier, 15, Rue Petitot, Geneva, banker; A. B. Pescatore, 7, Vincent Avenue, Chorlton-cum-Hardy, electrical engineer; H. O. Tudor, Rosport, Grand Duchy of Luxemburg, electrical engineer; T. Pescatore, 44, Central Road, Withington, electrical engineer; P. Pescatore, 7, Vincent Avenue, Chorlton-cum-Hardy, electrical engineer; E. Jacob, 6, Mauldreth Road West, Withington, electrical engineer; C. Beving, Hazlewood, Stockport Road, Altrincham, merchant. The number of directors is not to be less than three nor more than seven; the first are the first three subscribers. Qualification £200; remuneration as fixed by the company. Registered office, 5, Cross Street, Manchester.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

British Columbia Electric Railway Company, Limited (51,953).—This company's statutory return, made up to July 28th, has just been filed; 20,007 shares have been taken up out of a capital of £250,000 in £10 shares, and 20,000 are considered as paid; 5s. per share has been called and paid on the rest.

African Direct Telegraph Company, Limited (21,895).—This company's annual return was filed on June 16th, when 23,600 shares were taken up and paid for in full out of a capital of £300,000 in £10 shares.

Crompton & Co., Limited (27,200).—This company's annual return was filed on August 19th. The capital is £280,000, in £5 shares (of which 30,000 are preference); 5,928 ordinary and 28,180 preference have been taken up, and 4,000 ordinary are considered as fully-paid; £5 per share has been called on the preference, and £1 per share on 1,928 ordinary, resulting in the payment of £142,872, which includes £44 paid in advance of calls.

New Fowler-Lancaster, Limited (51,824).—This company's statutory return was filed on August 31st, when 18,468 shares were taken up out of a capital of £100,000 in £1 shares; £1 per share has been called on 16,664, and 5s. per share on 1,804, resulting in the receipt of £17,115.

Edison and Swan United Electric Light Company, Limited (18,984).—This company's annual return was filed on August 15th. The capital is £1,000,000 in 150,000 "A" and 50,000 "B" shares of £5 each; 116,400 "A" and 23,564 "B" have been taken up, and 17,139 of the former and all the latter have been issued as fully paid, while £3 per share has been considered as paid on the remaining "A" shares, 10s. per share has been called on 89,261 "A" shares, and £44,630 10s. has been paid.

British Thomson-Houston, Limited (47,982)—This company's annual return was filed on August 12th, when the capital of £240,000 in 4,000 "A" and 20,000 "B" shares of £10 each was fully taken up, 3,469 of the former and 4,000 of the latter are considered as paid; £10 per share has been called on 531 "A" and £5 per share on 16,000 "B" shares, and £85,310 has been paid.

CITY NOTES.

Brush Electrical Engineering Company, Limited.

The annual general meeting of this company was held last Friday at the Cannon Street Hotel, Mr. J. B. Braithwaite, jun., in the chair.

In moving the adoption of the report, the Chairman observed that the balance of profit carried to the balance-sheet was £18,962, or £14,347 more than last year. Roughly, this addition was made up of an increase in their earnings of £10,000, and a reduction in their expenses of £4,300. Their gross profit on trade in the past year was £32,655, as compared with £33,298 in the previous year, or practically the same. There was, however, in reality, a very considerable improvement on the previous year, because the figures of that year included the profit made at their Vienna factory, and the profit they realised on the sale of their Vienna business. He thought they would agree with him that the company had done well in making this good entirely in the past year, thus leaving the trading profit at the same figure as in the previous year. The profit realised on securities sold, interest account, and dividends on securities held also exhibited a considerable increase, owing largely to the sale of their Vienna business, which left them with a very large sum in hand, for which they had no immediate use. The result had been that they had received a very considerable sum as interest on it, and they had had larger dividends on their securities, some of which they had also realised at a considerable profit. The directors were entitled by the articles of association to £2,000 a year, but they had waived half that amount, as they did in the previous year. Their general charges this

year had been £11,970, or £1,000 less than they were in the previous year. They had made certain economies, the full benefit of which was not shown in the present accounts, but they had very nearly reached the end of the economies they could make without injuring their business. By the change they had made in their London office, they would effect a reduction of about £500 a year. They must not expect to see any reduction in the item of maintenance of buildings and plant, which it was absolutely necessary for them to keep in first-class order. The interest on the first debenture stock was the same, but the interest on the second debenture stock was nearly £1,000 more. They had had a drawing of £26,770 of second debenture stock, which would be repaid at 105 on the 1st prox., and from that date they would only pay interest on £50,000 instead of on £76,770. There would therefore be a substantial reduction next year in the interest payable on the second debenture stock. Their bad debts had amounted to only £96, or practically *nil* on a turnover such as theirs, and this reflected great credit on the officers for the care with which they had carried on the company's business. They could not, however, always expect to be so fortunate with regard to bad debts. Passing to the balance-sheet, he stated that the resolution passed by the shareholders at their meeting last year for reducing the capital of the company by £90,000 had been approved by the Court, and the balance-sheet was now made out in accordance with the revised figures. The item of creditors stood at £33,533 compared with £28,982 last year. This was owing to their increased turnover. Last year's balance-sheet showed that they had a loan from their bankers against security of £26,775, but in this year's balance-sheet that item had disappeared, and they had various large sums of cash available. Altogether they had about £75,000 in cash assets available, besides their shares and debentures in other companies. Their liability on shares in other companies amounted at the date of the balance-sheet to £3,700, but this had since been reduced to £1,200, which compared with £11,142 a year ago. On the credit side of the balance-sheet they took in their freehold factory at Loughborough at the valuation made last year by Messrs. Fuller, Horsey, Sons and Cassell, *plus* the amount expended on extensions of the factory during the year of £11,348. Having sold their Vienna factory, it had been necessary for them to extend their factory at Loughborough, in order to enable them to carry on manufactures previously conducted at Vienna. They were making further extensions at Loughborough, but he hoped that during the coming year their works would be completed in their new form. In making these extensions they believed they were fully justified by the business in hand and in prospect. At the present moment their works were running more than full time, and they had orders on hand which would keep them fully employed for a considerable period. Patents and goodwill stood this year at £181,397, or £25,000 less than last year. This was part of the appropriation of the reduction of capital authorised by the shareholders a year ago. It was always extremely difficult to put a cash value on patents; but when they went before the Court, the latter made very full inquiries into the value of their patents, and they gave the Court certain information which satisfied them that what the directors were doing was reasonable. Their stock now stood at £92,318, and with the stock at the Australian branch, the amount was £103,454, as compared with £100,662 in the previous year. They had sold their entire output during the past year, and in a business like theirs this was satisfactory, showing that their stock was not "a dead stock," but one which was constantly being turned over. The total of their debtors this year was £143,281, as compared with £140,433 a year ago. In a business like theirs there was always a very large difference between their creditors and their debtors. They owed only £40,000 in all, while the amount due to the company was about £144,000, so that they were about £100,000 to the good in this direction. All their debtors, however, were perfectly good. As regarded their shares and debentures in other companies, of the amount shown of £62,777, about £50,000 represented shares and debentures officially quoted on the Stock Exchange, and if the figure in the balance-sheet had been given at the prices at which these shares were quoted, an increase of about £14,000 or £15,000 would have been shown. They had not invested their money in shares and debentures of other companies for the sake of the immediate dividend they would receive, but in order that they might have an interest in the increment of capital value of those companies, which their own company had been the means of forming. The small amount in arrear on the preference shares would be paid at the same time as the dividend now proposed on the preference shares of 4 per cent. per annum. The bonus payable to the employés under the profit-sharing scheme would amount to £1,600, and they recommended that £5,000 should be placed to reserve fund, leaving £3,000 to be carried forward. They intended to invest the £5,000 of reserve fund in thoroughly first-class marketable securities, so that if they wanted it to meet any emergency they would not find it mixed up as a book entre in their business, but would be able to turn the investment into cash. As regarded their business generally, their manufactures were so varied that it must be a very bad year with them when they did not get good orders in one or two of their departments. Their business was on a broad basis, and he anticipated that one year with another they would keep their works fully occupied. Referring to the dispute in the engineering trade, he remarked that it was divided into two sections—a strike and a lock-out. The strike was confined to London, and did not affect the country at large. The Federation of Employers, however, he said, had taken on themselves the responsibility of extending the struggle throughout the country by inducing their members to lock out their men all over the country, not because they had any quarrel with them, or because the men were asking for anything that was objected to by the employers, but because the latter were afraid that if an eight hours' day became general in London a similar demand might be made throughout the country. After the fullest consideration, the directors came to the conclusion that they ought not to join the Federation of Employers in their action, and their men were therefore working as usual. He might state that the relations between their men and employés had always been friendly. It was only by masters and men working intelligently and harmoniously together that they could possibly hope to retain that commanding position which England enjoyed in the engineering trade. If they did as well in the current year as they did last year, there ought to be a small dividend for their ordinary shareholders.

Mr. B. H. Van Tromp seconded the motion.

A Shareholder asked what was the amount of patents and goodwill?

The Chairman said it was impossible to divide them.

After some further remarks, the resolution was adopted.

Rockhampton Gas and Coke Company, Limited.

The directors' report to the shareholders for the half-year ended June 30th, 1897, says:—"Reference has already been made in a former report to the introduction by the Government of an 'Electric Light and Power Act,' which deals with the whole question of the electric light enterprises in Queensland. On and after January 1st, 1898, this company will be subject to the clauses of that Act, and in pursuance of the provisions thereof, the directors are now applying to the various local authorities in whose areas it is proposed to operate, for their sanction to the granting of an order to the company by the Governor-in-Council. The electrical operations show a return of £189 3s. 11d., which has gone towards the payment of the interest upon the debentures, leaving a difference of £110 16s. 1d., represented in the debit balance of the profit and loss account of this section of the business."

Profit and Loss Account.

Electric Light Operations for the half-year ended June 30th, 1897.

Dr.	£	s.	d.
To Generating electric current	470	3	6
„ Management, &c.	63	19	9
„ Printing...	9	15	8
„ Interest...	300	0	0
„ Stationery	5	11	7
„ Insurance	20	0	0
„ Private arc maintenance	12	9	11
„ Advertising	5	14	8
	£887	6	1

Cr.	£	s.	d.
By Electric current sales	640	13	6
„ Sundries...	13	6	5
„ E.L. fitting account	83	12	3
„ Interest	8	17	1
„ Rental on E.L. fittings	30	0	9
„ Balance	110	16	1
	£887	6	1

Under Assets in balance-sheet there appear these items:—

By Sundry debtors for gas and electric light	£1,467	14	11
„ Electric light plant	11,178	7	5
„ Electric light fittings on rental	869	6	8
„ Electric light fittings in stock	1,382	10	7

Willans & Robinson.—This company notify that the registers of transfers and members will be closed, prior to the ordinary general meeting, from September 22nd to October 6th, both days inclusive.

Stock Exchange Notice.—The Stock Exchange Committee has also ordered the under-mentioned securities to be quoted in the Official List;—County of London and Brush Provincial Electric Lighting Company, Limited: Further issue of 7,525 ordinary shares, Nos. 22,476 to 30,000.

Stock Exchange Settlements.—Application has been made to the Stock Exchange Committee to allow the following securities to be quoted in the Official List:—Westminster Electric Supply Corporation, Limited—Further issue of 12,000 ordinary shares, Nos. 68,001 to 80,000.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending September 19th, 1897, were £897; week ending September 20th, 1896, £872; increase, £25; total receipts for half-year, 1897, £10,802; corresponding period, 1896, £10,887; decrease, £85.

The Liverpool Overhead Railway Company. The receipts for the week ending September 19th, 1897, amounted to £1,401; corresponding week last year, £1,214; increase, £187.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending September 17th, 1897, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £2,958.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1894.	1895.	1896.	Closing Quotation, Sept. 15th.	Closing Quotation, Sept. 22nd.	Business done during week ended Sept. 22nd, 1897. Highest.	Lowest.
149,900£	African Direct Teleg., Ltd., 4 % Deb.	100	4 %	4 %	...	100 - 104	100 —104	100¾	...
25,000	Amazon Telegraph, Limited, shares...	10	...	...	...	5 — 6	5 — 6	6	...
923,960£	Anglo-American Teleg., Ltd.	Stock	£2 2s.	£2 9s.	£2 13s.	58 — 60	58 — 60	...	...
3,038,020£	Do. do. 6 % Pref.	Stock	£4 4s.	£4 18s.	£5 6s.	105 — 106	104½ — 105½	106½	105
3,038,920£	Do. do. Defd.	Stock	...	...	...	12¼— 12⅝	12¼— 13	13⅜	12 9/16
130,000	Brazilian Submarine Teleg., Ltd.	10	7 %	7 %	...	15 — 15½	15½— 15⅝	15 5/16	15 1/16
75,000£	Do. do. 5 %, Debs., 2nd series, 1926	100	5 %	5 %	...	113 - 117	113 —117	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 44,000	5	2½%	4 %	4 %	3½— 3⅝	3½— 3⅝	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	7 %	178 - 183 xd	178 —183 xd	...	...
653,586£	Do. Do. Sterling 500 year 4% Deb. Stock Red.	Stock	...	...	...	107 —108	107 —108	108	107½
224,850	Consolidated Telep. Const. and Main., Ltd.	10/-	1½%	1½%	2 %	7/16— 8/16	7/16— 8/16	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	8 %	8½ — 9½	8½ — 9½	...	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	18½ — 19½	18½ — 19½	19⅛	18¾
12,931	Direct Spanish Teleg., Ltd.	5	4 %	4 %	4 %	4 — 5	4 — 5	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	10 %	10 — 11	10 — 11	...	...
30,000£	Do. do. 4½ % Debs. Nos. 1 to 6,000 ...	50	4½%	4½%	4½%	103 —106 %	103 —106%	...	...
60,710	Direct United States Cable, Ltd.	20	2 %	2½%	2½%	10 — 10¼	10 — 10½	10⅜	10⅛
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½%	6½%	6½%	16⅜ — 17⅛	16⅜ — 17⅛	17 3/16	16¾
70,000	Do. 6 % Cum. Pref.	10	6 %	6	6%	17½ - 18½	17½ — 18½	...	...
89,900£	Do. 5 % Debs., repay. August, 1899	100	5 %	5 %	5%	101 - 104	101 —104	...	...
1,302,615£	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	4%	130 - 135	130 —133	131⅛	131
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7 %	7¾	17½ — 18	17½ — 18	18	17 11/16
35,500£	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	5 %	5 %	5%	99 - 103	99 —103	102½	...
133,100£	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	5 %	5 %	5%	100 - 103	100 —103	...	...
320,000£	Do. 4 % Deb. Stock	Stock	4 %	4 %	4%	129 —132	129 —132	129½	...
51,100£	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5 %	5%	99 - 103	99 —103	...	...
69,200£	Do. do. to bearer, 2,344 to 5,500	100	5 %	5 %	5%	100 - 103	100 —103	...	...
300,000£	Do. 4 % Mort. Debs. Nos. 1 to 3,000, red. 1909	100	4 %	4 %	4%	103 - 106	103 —106	...	...
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4 %	4%	108 - 111 %	108 —111%	108	...
180,227	Globe Telegraph and Trust, Ltd.	10	4½%	4½%	4½%	11½ — 12	11½ — 12	11 15/16	11⅝
180,042	Do. do. 6 % Pref.	10	6 %	6 %	6%	16⅝— 17⅛	16⅝— 17⅛	17⅛	16⅞
150,000	Great Northern Teleg. Company of Copenhagen	10	8⅝%	10 %	10⅞	26½ — 27½	26½ — 27½	27⅝	27¼
160,000£	Do. do. do. 5 % Debs.	100	5 %	5 %	5%	102 —105	102 —105	102	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	10%	54 — 57	54 — 57	55	54½
100,000£	London Platino-Brazilian Teleg., Ltd. 6 % Debs.	100	6 %	6 %	6%	105 —108	106 —109	...	...
28,000	Montevideo Telephone 6% Pref., Nos. 1 to 28,000... ...	5	4 %	4 %	...	2 — 2½	2 — 2⅛	...	...
484,597	National Teleph., Ltd., 1 to 484,597	5	5 %	5⅛%	5⅛%	6⅜— 6⅝	6½ — 6⅝	6 11/16	6 9/16
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	15 — 17	15 — 17	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	15 — 17	15 — 17	...	...
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 119,234	5	5 %	5 %	5 %	6 — 6½	6 — 6½	6 3/16	6
1,329,471£	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	105 —110	105 —110	107¼	106½
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	4½%	5 %	5 %	9/16— 11/16	9/16— 11/16	...	...
100,000£	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,999	100	4 %	4 %	4 %	107 - 110	107 - 110	...	...
11,839	Reuter's Ltd.	8	*nil*	5 %	5 %	7 — 8	7 — 8	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	136 —141	136 - 141	...	...
58,000	United River Plate Teleph., Ltd.	5	3 %	4 %	...	3⅜— 4¼	3⅜ — 4¼	...	...
146,733£	Do. do. 5 % Debs.	Stock	5 %	5 %	...	102 -107	102 —107	...	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	*nil*	4 %	nil	5 — 6	5 — 6	...	...
213,400£	Do. do. do. 5 % Debs.	100	5 %	5 %	5 %	103 - 106	103 —106	104	...
64,256	Western and Brazilian Teleg., Ltd.	15	2 %	2 %	2 %	9 — 9½	9¼— 9⅝	9⅝	9¼
33,129	Do. do. do. 5 % Pref. Ord. ...	7½	5 %	5 %	5 %	7 — 7½	7¼— 7⅝	7⅝	7¼
33,129	Do. do. do. Def. Ord.	7½	1 %	1 %	...	2½ — 3	2½ — 3	2 13/16	...
382,230	Do. do. do. 4 % Deb. Stock Red. ...	Stock	...	...	...	101 —104	103 —105	103	...
88,321	West India and Panama Teleg., Ltd.	10	⅛%	⅛%	1 %	⅜— 1	⅜— 1	13/16	...
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	10 — 10½	10 — 10½	10⅝	10
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	7½— 8½	7½— 8½	...	...
80,000£	Do. do. 5 % Debs. No. 1 to 1,600 ...	100	5 %	5 %	5 %	106 —109	106 —109	...	...
1,163,000$	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$1000	7 %	7 %	7%	106 —110	106 —110	...	...
160,100£	Do. do. 6 % Ster. Bonds.	100	6 %	6 %	6%	100 —105	100 —105	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electy. Supply	5	4½%	5 %	6 %	12½— 13½	12½— 13½	12¾	12⅝
20,000	Do. do. do. do. 4½ % Cum. Pref.	5	...	...	...	6 — 6½	6 — 6½	6⅛	...
26,000	*Chelsea Electricity Supply, Ltd., Ord., Nos. 1 to 10,277 ...	5	5 %	5 %	5 %	10 — 10½	10 — 10½	...	...
60,000	Do. do. do. 4½ % Deb. Stock Red. ...	Stock	...	4½%	4½%	110 —113	110 —113	...	...
40,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,001—80,000	10	5 %	5 %	7 %	25 — 26	25 — 26	25½	...
10,000	Do. do. Prov. Certs.	5	...	...	...	23½— 24½	23½— 24½	...	...
40,000	Do. do. 5 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	17 — 18	17 — 18	...	...
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	130 —135	130 —135	...	...
22,475	County of Lond. & Brush Prov. E. Ltg. Ltd., Ord. 1—22,475	10	...	*nil*	*nil*	12⅜— 13¼	12⅜— 13¼	12 15/16	12⅞
20,000	Do. do. do. 6% Pref., 40,001—60,000 ...	10	...	6 %	6 %	15¼— 15⅝	15¼— 15⅝	...	...
10,000	House-to-House Elec. Light Supply, Ord., 101 to 10,100	5	...	...	...	9 — 9¼	9 — 9½	...	...
10,000	Do. do. 7 % Cum. Pref. ...	5	...	...	...	10¾— 11¼	10¾— 11½	11½	11
49,900	*Metropolitan Electric Supply, Ltd., 101 to 50,000 ...	10	3 %	4 %	5 %	17 — 18	17½— 18½	18	...
12,500	Do. Ord., 50,001—62,500, iss. at £2 prem.	10	...	...	...	16 — 17	16½ — 17½	17¼	17
220,000	Do. 4½% first mortgage debenture stock	...	4½%	4½%	4½%	118 —122	118 —122	121	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	1 %	2 %	4 %	15 — 16	15 — 16	15¾	...
19,980	*St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-20,080	5	6½%	7½%	10½%	16½— 17½	16½— 17½	...	...
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	10 — 11	10 — 11	10⅜	...
50,000	Do. do. 4 % Deb. stock Red. ...	Stock	...	...	...	103 —106	103 —106	...	...
67,900	*Westminster Electric Supply Corp., Ord., 101 to 69,900 ...	5	5 %	7 %	9 %	14½— 15½	14½— 15½	15½	...

* Subject to Founder's Shares.
† Quotations on Liverpool Stock Exchange.
‡ Unless otherwise stated all shares are fully paid.
‖ Dividends paid in deferred share warrants, profits being used as capital.
§ Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share ‡	Dividends for the last three years. 1894.	1895.	1896.	Closing Quotation Sept. 15th.	Closing Quotation, Sept. 22nd.	Business done during week ended Sept. 22nd, 1897. Highest	Lowest.
20,000	British Electric Traction	10	...	...	...	13 — 13½	13 — 13½	13 7/16	13½
90,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000...	5	2½%	...	...	¾ — 1	¾ — 1	...	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	3 %	...	...	1½ — 1¾	1½ — 1¾	1 1/16	1⅛
125,000‖	Do. do. 4½ % Perp. Deb. Stock.... ...	Stock	4½%	...	...	103 —107	103 —107 xd	...	...
76,770	Do. do. 4½% 2nd Deb. Stock Red. ...	Stock	...	...	...	94 — 98	94 — 98	...	...
19,126	Central London Railway, Ord. Shares	10	...	...	...	9¾ — 10¼	9¾ — 10¼	10⅛	...
143,105	Do. do. do. £6 paid	10	...	...	...	5¾ — 6¼	5¾ — 6¼	...	...
58,830	Do. do. Pref. half-shares £1 pd. ...	...	...	...	...	1½ — 1⅝	1½ — 1⅝	1 1/16	...
61,777	Do. do. Def. do. £5 pd. ...	...	...	...	...	4¼ — 4⅜	4¼ — 4⅜	...	...
630,000‖	City and South London Railway	Stock	1½%	1 3/16%	1 9/16%	66 — 68	67 — 69	68½	67½
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	*nil*	*nil*	...	1½ — 2	1½ — 2	...	...
89,261	Edison & Swan United Elec. Lgt., Ltd., "A" shrs, £3 pd. 1 to 89,261	5	5 %	5 %	...	2¼ — 2⅜	2¼ — 2⅜	2 5/16	2 5/16
17,139	Do. do. do. "A" Shares 01—017,139	5	5 %	5 %	...	4 — 4½	4 — 4½	...	...
110,000	Electric Construction, Ltd., 1 to 110,000	2	*nil*	5 %	6 %	1⅜ — 2	1⅜ — 2⅛	2 1/16	2
16,343	Do. do. 7 % Cum. Pref., 1 to 16,343 ...	2	7 %	7 %	7 %	3 — 3½	3 — 3½	3¼	3 3/16
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	*nil*	...	...	5/32 — 7/32	5/32 — 7/32	...	...
67,275	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ..	2	*nil*	...	...	5/32 — 7/32	5/32 — 7/32	...	...
9,600‖	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ..	10	*nil*	10½%	...	9 — 11	9 — 11	...	...
12,500	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	6 %	8 %	10 %	18½ — 19½	18½ — 19½	19⅜	19¼
3,000	Do. do. do. 7% Pref.	10	7 %	7 %	7 %	18 — 19	18 — 19	...	...
50,000	Do. do. do. 4½ Mort. Deb. Stock	Stock	...	4½%	4½%	109 —114	109 —114	...	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	10 %	10 %	10 %	21 — 22	21½ — 22½	22⅛	21⅝
300,000	Do. do. do. 4 % 1st Mort. Debs.	100	...	...	...	105 —108	105 —108	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	1½%	2¾%	2¾%	11¼ — 11⅛	11 5/16 — 11 7/16	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5 %	16 — 16½	16 — 16½	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	20 %	15 %	15 %	36 — 39	36 — 39	38⅜	37
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	102 —105	102 —105	...	...
54,000‖	Waterloo and City Railway, Nos. 1 to 54,000, £8 paid ...	10	...	...	...	10¾ — 11¼	10¾ — 11¼	...	...

Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 50% for 1890.

Dividends marked ‖ are for a year consisting of the latter part of one year and the first part of the next.

Crompton & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—6%; 1893—7%; 1896—8%.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Birmingham Electric Supply Company, Ordinary of £5 (£4 paid), 7⅞, £5 (fully paid) 9½.

Electric Construction Corporation, 6 % Debentures, 104 –107.

House-to-House Company, 4½% Debentures of £100, 108 –111.

Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid) 13½—14½; 1st Preference Cumulative 6 %, £5 (fully paid), 8¼—8¾. Dividend, 1896, on Ordinary Shares 7 %.

London Electric Supply Corporation, £5 Ordinary, 1⅜—2.

Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 8—8½. Dividend for 1896—6 %.

* From Birmingham Share List.

Bank rate of discount 2 per cent. (May 13th, 1897).

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.—TORONTO, 1897.

SOME TESTS ON THE VARIATION OF THE CONSTANTS OF ELECTRICITY SUPPLY METERS, WITH TEMPERATURE AND WITH CURRENT.

By G. W. Donald Ricks, A.C.G.I., A.I.E.E.

(Section G.)

(Continued from page 390.)

The law of the meter may be expressed thus, assuming, however, that the fluid friction is proportional to the square of the speed throughout the whole range.

Let A = main current.
M_A = magnetisation due to the current A.
M_R = residual magnetisation.
w = angular speed of the armature.
$q w^2$ = force due to fluid friction.
p = force due to solid friction.
k = a constant.

Then $k A (M_A + M_R)$ = total driving force,

and $p + q w^2$ = total retarding force.

For steady motion,

$$k A (M_A + M_R) = p + q w^2.$$

Assuming magnetisation proportional to the current

$$M_A = b A,$$

and residual magnetisation constant

$$M_R = r,$$

Then $$k A (b A + r) = p + q w^2,$$

$$k b A^2 = q w^2 + p - k A r.$$

If the retarding force due to solid friction is exactly neutralised by the driving force due to residual magnetism,

$$p = k A r,$$

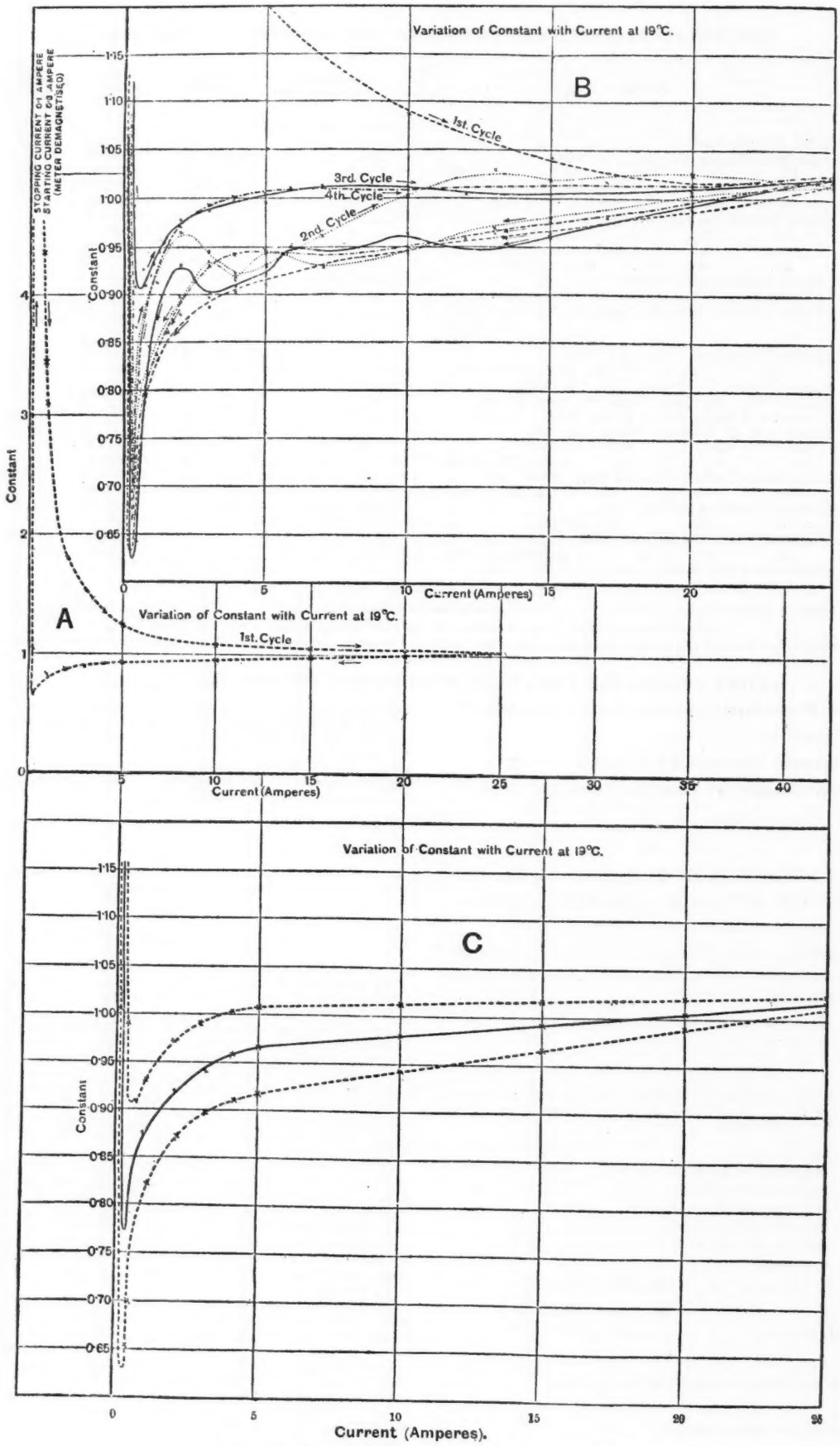
and $$A^2 = \frac{q}{k b} w^2,$$

that is, the speed is proportional to the current.

This meter is made up in an extremely compact form, and has the great advantage of simplicity of construction. The substitution of residual magnetism for that proposed by shunt windings used in an earlier pattern, has removed one of its principal drawbacks, the waste of energy in the shunt. It possesses, however, the disadvantages attendant upon comparatively small driving and brake forces, necessitating the employment of an extremely light and frictionless counting mechanism, which, owing to its very delicate construction, must require very careful handling. It is also essential that the mercury used should be of the highest degree of purity, for the law of the meter depends directly on its viscosity, which would be seriously affected by impurities even in small quantity.

The tests on this meter revealed several characteristic points not found in any of the other meters tested. In the first place the constant at low currents was found to have a low value, giving a curve of quite a different shape. Then it was noticed that for any given value of the current the constant varied according to whether the current had risen or fallen to that value, and a third peculiarity is that its temperature coefficient is very small and positive as the constant increases and the temperature rises. Its mean value is about 0·07 per cent. per °C.

The same meter was very carefully tested for variation of constant with current by Messrs. Nelson, Kerr and Gray, students at the Central Technical College, as well as by myself, and I am indebted to them for some of the following results. Previous tests had shown the nature of the curve, viz., that the constant apparently began at a very low value just after the meter started, and rapidly increased with increasing current. A few preliminary readings gave a similar result, and as it appeared to be due to the residual magnetism overbalancing the friction, the effect of demagnetising was tried, and gave the marked result shown graphically on Sheet III. In carrying out all the tests with this meter it was found necessary to put it through a regular cycle of current, starting from zero, increasing to a maximum, and decreasing again to zero. The constant was taken at frequent intervals, and the first cycle shown completely on Sheet IIIa. clearly



SHEET III.—Ferranti Meter. (Max. Current, 25 Amperes.)

indicates the effect of unbalanced friction. As the current is increased from zero to a maximum, the constant, commencing at a high value, descends in a sort of hyperbolic curve, exactly as one would expect it would if there were a constant excess of retarding torque over driving torque. During the remaining half cycle we have again what would be looked for if there were a constant excess of driving torque over retarding torque, namely, an inverted hyperbola. This course bends up very sharply just before reaching the stopping current.

This operation was continued until the curves for two succeeding cycles were nearly coincident, which occurred with those of the third and fourth cycles. These are shown graphically on Sheet IIIb, from which it will be seen that, although the curves for the different cycles appear to be very irregular, still they all lie chiefly within an area enclosed by the descending half of the fourth cycle. The irregularities may be accounted for by variations in the lag of magnetisation caused by some such disturbing influence as vibration.

Table III.—*Ferranti Meter.*

Maximum current 25 amperes. Current varied. Temperature 19° C. $a = 430$. $K^1 = 1$.

Current A.	Current increasing.		Current decreasing.		Mean.
	w	K	w	K	
0·5	0 0658	0·906	0·085	0·700	0·803
1	0·1285	0·930	0·1458	0·820	0·875
2	0·2460	0·972	0·2755	0 867	0 920
3	0 3622	0 990	0·4020	0 894	0·942
4	0·4775	1·001	0·527	0·909	0 955
5	0·5940	1·005	0 653	0·917	0·961
10	1·180	1·012	1·266	0·943	0·978
15	1·755	1·020	1·856	0·965	0·993
20	2·330	1 024	2·419	0 988	1·006
25	2 915	1·025	2·950	1·013	1·019

On Sheet IIIc will be found curves showing the maximum variation of the constant with current and the mean value at any given current. The dotted curve indicates the amount to which the constant may vary at any given current by reason of variation in the lag of magnetisation. For increasing current this lag causes a decrease in the driving torque, and consequently a higher value of the constant than is the case when the current is decreasing. In ordinary working, however, these effects of lag would probably neutralise each other, and the mean curve shown in full line would represent mean working value of the constant.

(To be continued.)

ON A NEW METHOD OF MEASURING HYSTERESIS IN IRON.*

By J. L. W. Gill.

(Section G.)

When a specimen of iron is passed to and fro through a magnetic field without any motion of rotation, the direction of the field being reversed each time the specimen passes out of the field, the iron passes through a complete magnetic cycle for each cycle of motion, and a definite amount of energy is lost, due to hysteresis in the iron. Since energy is supplied only in the form of mechanical work upon the specimen, the hysteresis loss is, by the law of the conservation of energy, numerically equal to the resultant mechanical work expended.

The instrument described below is based upon the above principle, and its function is to measure the work so expended.

The magnetic field is obtained by the use of a solenoid wound on a brass tube. This solenoid is arranged vertically and has a vertical motion, the ends of the solenoid being fitted with collars, which slide on two rigid vertical rods. An arm is fastened rigidly to the solenoid, and extends out on one side. To this arm is fastened a cord, which passes over a grooved pulley vertically above. A balance weight is attached to the other end of the cord. By rotating the grooved pulley the solenoid may be moved up and down, and will remain in any desired position. The specimen to be tested is placed in a stirrup, which is sufficiently small to pass through the solenoid, and is suspended by a helical spring, the point of suspension being vertically above the centre of the solenoid. Another helical spring extends from the bottom of the stirrup to a point vertically below. This serves to keep the stirrup steady. The stirrup is suspended so that when the solenoid is in its lowest position the specimen is out of the magnetic field, being above the solenoid. As the solenoid is moved up the stirrup and specimen pass through it, and when the solenoid is in its highest position the specimen is practically out of the field. If the solenoid be moved once up and down, the field being reversed when the specimen is out of it, the specimen passes through a complete magnetic cycle, provided the specimen has been once through the field and is initially in that particular cyclic state.

As the solenoid is moved up the specimen is attracted down, the force of attraction increasing until it reaches a maximum, when about one-half of the specimen is inside the solenoid. The attraction then decreases and becomes zero when the specimen is in the centre of the solenoid. Up to this point work is being done by the magnetic force. As the solenoid is moved up to its highest position the specimen is attracted upward, and work is done against the magnetic force; the attracting force becomes a maximum when the specimen is about one-half out of the solenoid on the lower side, and becomes zero when the solenoid is in its highest position. The maximum force in the second half of the motion is greater than the maximum force in the first half. The work done in the second half of the motion is also greater than that done in the first half, the difference being the work expended in taking the specimen through half a cycle. When the field is reversed and the solenoid moved down, the action is similar to that which takes place when the solenoid is moved up, and the resultant work done will be the same, provided the specimen is homogeneous.

The resultant work done on the specimen may be determined by observing the attracting force when the solenoid is in different positions, and then drawing a distance-force curve. The integral of this curve gives the resultant work done on the specimen. The force at different points can be determined by calibrating the springs which support the stirrup, and then observing the extension of these springs. The author has determined the hysteresis loss in different specimens at different inductions by this method, the extension of the spring being observed with the aid of a microscope.

To make this method practical, a simple integrating apparatus is attached to the instrument above described, by which the work done is integrated automatically. A glass disc is connected rigidly to the pulley which moves the solenoid, so that when the pulley rotates the glass disc rotates in its own plane, which is vertical, the axis of rotation passing through its centre. The motion of the glass disc is therefore proportional to the motion of the solenoid. An arm is fastened to the stirrup which supports the specimen, and extends up to the glass disc. This arm supports a graduated steel disc, which is free to rotate in its own plane about a vertical axis through its centre. This steel disc presses lightly on the glass disc, the point of contact being at the centre of the glass disc. When the solenoid is moved up the specimen is attracted down, taking the stirrup with it. This causes the steel disc to recede from the centre of the glass disc. A motion of rotation is then communicated to it by the glass disc, the speed of rotation depending on its distance from the centre; since its distance from the centre at any instant is proportional to the attracting force, and the motion of the glass disc is proportional to the motion of the solenoid, the speed of rotation of the disc is proportional to the work being done at that instant. The total amount of rotation is therefore proportional to the total work done. Consequently all that is necessary to test a specimen with this instrument is to place the specimen in the stirrup, move the solenoid up and down to get the specimen in a cyclic state, then take it through a cycle, and observe the amount of rotation communicated to the steel disc. This is a direct measure of the work expended.

The constant of the instrument is determined by placing a known weight in the stirrup, and observing the amount of rotation communicated to the disc when the solenoid is moved through a known distance.

The specimen may be taken through a number of cycles and the readings allowed to accumulate. The average of a number of cycles is thus obtained.

* Abstract.

ON SOME NEW FORMS OF GAS BATTERIES AND A NEW CARBON-CONSUMING BATTERY.

By Willard E. Case.

(Section A.)

In 1839 Grove announced his discovery of the gas battery, considering it the most simple arrangement to produce electricity. He never considered it a practical way to generate electrical energy. Grove used platinum sponge or platinum black as the absorbent to facilitate the combination of the gases. The following experimental determinations by the author will show, as far as they extend, that platinum or its compounds are not necessary to produce the combination of the gases in the production of electrical energy, so doing away with one of the most expensive drawbacks to the gas battery. The experiments also prove that carbon is oxidised to CO_2 at normal temperature without the application of heat with the production of electrical energy.

In these experiments it will be noted that platinum is not essential to the reactions. Both electrodes in each case can be carbon tubes or plates. The physical condition of the carbon in its many forms plays a most important part.

The Chlorine-Carbon Cell.—A porous carbon-tube electrode into which chlorine gas was passed, opposed to a carbon rod which had been heated red-hot, was placed in hydrochloric acid, of specific gravity 1·10. An electromotive force of from 0·50 to 0·54 volt was obtained, depending on the condition of the carbons.

The carbon electrodes, after being heated, were again assembled and placed in distilled water. With no gas passing through, they gave an electromotive force of 0·00. When the chlorine gas was passed into the carbon tube, at slightly above atmospheric pressure, the electromotive force gradually increased to 0·44 of a volt at the end of 26 hours. On short circuit 0.04 of an ampere was obtained, but it dropped rapidly to 0·02. The internal resistance was very high. The electrodes were taken out and the solution analysed. It was found to contain hydrochloric acid and carbon dioxide. The same experiment was repeated in a dark case to see if the action took place in the absence of light. The chlorine gas was made in the dark and passed through the electrode. The electromotive force gradually increased, as in the first case, showing that the action took place in the dark.

A carbon electrode, through which chlorine was passed, and a negative platinum electrode opposed to it in dilute hydrochloric acid gave 0·40 of a volt, but the electromotive force did not hold up through the volt-meter circuit. Both electrodes were covered with

gas after short circuiting, and the electromotive force dropped to 0·24 of a volt. On shaking, the voltage jumped to 0·40.

A negative carbon electrode was substituted for the negative platinum. It had been heated red-hot and was very porous, the surface soft and rough. The electromotive force reached 0·58 of a volt, and gave on short circuit 1·24 amperes, but dropped slowly to 0·30. The negative carbon electrode was oxidised.

A platinum electrode in a paper envelope, opposed to powdered carbon in the bottom of a glass jar in hydrochloric acid, chlorine being passed into the solution near the platinum. An electromotive force of 0·60 of a volt, and on short circuit 0·90 ampere, was obtained. The current remained fairly steady. The surface of each electrode was about 45 square inches.

A cell made up as above, but with graphite instead of carbon, gave 0·54 of a volt, but dropped rapidly on short circuit, the graphite not oxidising fast enough to give a steady current.

A dense carbon rod opposed to powdered carbon gave 0·40 of a volt, and on short circuit 0·20 of an ampere. The rod was incased in filter paper to protect it from floating particles of powdered carbon, and the chlorine passed into the solution near it.

Two small glass beakers connected by an inverted U tube and containing hydrochloric acid, with a carbon rod in one and platinum plate in the other. When chlorine was passed into the vessel with the platinum, an electromotive force of 0·48 volt was obtained. When chlorine was passed into the beaker containing the carbon rod, an electromotive force of 0·14 was obtained, but it dropped almost immediately to 0·00. When chlorine was passed into both beakers, no electromotive force was obtained.

The chemical reaction of the chlorine carbon cell was as follows:—

$$H_2O + Cl_2 = 2\,H\,Cl + O.$$

The oxygen of the decomposed water attacking the carbon, and hydrochloric acid and carbon dioxide being formed.

Carbon monoxide—chlorine cell—cell made as follows:—A glass tube, 2 25-inch bore and 6 inches long, corked at each end with a porous tube 1 inch outside diameter, passing through the glass tube and corks and corked at each end, carbon rods and gas inlet and outlet tubes let into each chamber, which were filled with dry animal charcoal previously treated with hydrochloric acid. The porous tube was saturated with concentrated hydrochloric acid. Chlorine gas was passed through the outer tube. An electromotive force of 0·18 volt was obtained. Then carbon monoxide gas was passed through the inner tube, and the voltage increased to 0·38 volt. A slight increase of the pressure of the gases increased the voltage. The glass tube became hot. This reaction would produce carbon oxychloride.

Marsh gas—chlorine cell.—Two carbon tube electrodes, $\frac{3}{4}$-inch in diameter and 4 inches long, opposed to one another in a solution of hydrochloric acid, with chlorine passed into one and Marsh gas into the other, gave an electromotive force between 0·60 and 0·70 volt, varying with the condition of the carbon. A current of 0·70 ampere was obtained on short circuit, but the cell rapidly polarised. Afterwards fresh carbon electrodes, with the gases passing through them, were placed in distilled water, and the electromotive force gradually increased from 0·00 to 0·14 in 12 hours.

On testing the solution hydrochloric acid and carbon dioxide were found to be present. The chemical reaction of this cell is as follows:—

$$CH_4 + 4\,Cl_2 + 2\,H_2O = CO_2 + 8\,H\,Cl.$$

The calculated electromotive force of this cell is 0·65 volt.

In making these determinations of electromotive force and current, a Western direct-reading voltmeter and milammeter were used. Resistance of voltmeter, 352 ohms; reading from 0·01 to 3·00 volts. The ammeter read from 0·01 to 2·00 amperes.

In all the experiments the gases used were but slightly above atmospheric pressure. Owing to limited time, the author is not able to furnish data. Experiments to determine the many interesting questions involved are being conducted.

Mr. C. E. Timmerman, of Cornell University, who has assisted me, has taken great care, with the limited time at our disposal, to verify these results.

THE COST OF STEAM POWER.*

By HORATIO A. FOSTER.

(*Concluded from page* 391.)

Table XI. shows results for high speed, automatic engines, which are also assembled irrespective of time of running or power developed, and show very uneven costs.

Tables XII. and XIII. include but one plant each, and are, therefore, of little use for comparison, excepting as showing the general variation of cost.

Table XIV. shows like results for three pumping stations, and one gets a very good idea of the vast difference in unit cost of power when developed in widely varying quantities; the first plant developing 1,352 H.P., and the other two less than 50 H.P. each, the difference in cost between the highest and the lowest being as $.007 is to $.03048.

In Table XV. is shown the cost for four large plants using slow speed, compound condensing engines. This type of plant is perhaps the most common of modern plants in use for large quantities of power, and is one on which perhaps the most and best estimates have been made, and therefore most easily compared with other tables.

Table XVI. shows the result in one plant using a large triple compound engine of special type, and one of the items tending to low cost in this instance, is that but half the engineer's time is chargeable to this particular plant; another being the low fixed charge owing to very close buying by the management. The cost of power here will be seen to be less than generally estimated.

Table XVII. shows the results in two mixed plants of large size, both cotton mills. In both cases about half the plant consists of the best type of compound condensing engines, while the remainder is made up of the old-fashioned double Corliss part condensing type, the exhaust from one end of each cylinder being generally used for purposes of heating about the mills. In passing, it may be well to say that most of the modern cotton mill plants use steam for heating direct from the boiler through pressure reducing valves, and not from any part of the exhaust of the engines.

Table XVIII.—*Emery's Tables Reduced to Indicated Horse-Power and Coal at* $3.00 *per* 2,000 *lbs.* 3,080 *Hours Run.*

Style of engine.	Operating expense.				Fixed charges.		Total.	Total cost.
	Coal.	Labour.	Repairs and supplies	Total.	Insurance, taxes and renewals.	Interest.		
A	$19.70	$4.41	$2.73	$26.84	$2.72	$5.90	$8 62	$35.46
B	17.34	4.04	2.28	23.66	2.82	6.13	8.95	32.61
C	15.54	3.84	2.73	22.11	2 52	5.49	8.01	30.12
D	14.35	3.68	2.73	20.76	2.78	6.03	8.81	29 57
E	13.15	3.51	$2.73	19.39	2.32	5.04	7.36	26.75
F	11.94	3.31	2.28	17 53	2.46	5.35	7.81	25.34
G	11.05	3.35	2.73	18.03	2 39	5.16	7.57	25.60
H	10.76	3.14	2.28	16.18	2.50	5.43	7.93	24.11
I	10.15	3 10	2.73	15 93	2.53	5.49	8.02	24.00
J	9.56	2.98	2.28	14 82	2.82	6.11	8.93	23.75
K	8.96	2.90	2.28	14.14	3.02	6.56	9.58	23.72
L	7.50	3.36	2.28	13.14	2.98	6.45	9.43	22.57

Table XIX.—*Emery's Tables Reduced to Indicated Horse-Power and Coal at* $3.00 *per* 2,000 *lbs.* 7,300 *Hours Run.*

Style of engine.	Operating expense.				Fixed charges.		Total.	Total cost.
	Coal.	Labour.	Repairs and supplies	Total.	Insurance, taxes and renewals.	Interest.		
A	$44.70	$10.45	$6.47	$61.62	$2.72	$5 90	$8.62	$70.24
B	39.20	9.57	5.38	54.15	2.83	6.13	8 96	63.11
C	35.20	9.11	6 47	50.78	2.53	5.49	8.02	58 80
D	32.50	8.72	6.47	47.69	2.78	6.02	8 80	56.49
E	29 70	8 34	6.47	44.51	2 32	$5.04	7.36	51.87
F	27.10	7.84	5 38	40.32	2.46	5.35	7.81	48.13
G	27.10	7.93	6.47	41.50	2.39	5.17	7.56	49.06
H	24.30	7.45	5.38	37.13	2.50	5.44	7.94	45 07
I	22 90	7.35	6.47	36.72	2.53	$5.49	8.02	44.74
J	21.64	7.07	5.38	34 09	2.81	6.14	8.95	43.04
K	20.30	6.85	5 38	32 53	3.02	6.57	9.59	42 12
L	16.93	7.98	5.38	30.29	2.98	6.44	9.42	39.71

Table XX.—*Cost per Horse-Power Hour, from Emery's Tables.* 3,080 *Hours Run.*

Style of engine.	Operating expenses.	Fixed charges.	Total cost.
A	$·00870	$·00280	$·01150
B	·00769	·00291	·01060
C	·00719	·00261	·00980
D	·00675	·00286	·00961
E	·00630	·00239	·00869
F	·00570	·00254	·00824
G	·00587	·00246	·00833
H	·00526	·00258	·00784
I	·00520	·00261	·00781
J	·00482	·00290	·00772
K	·00460	·00311	·00771
L	·00428	·00307	·00735

* Abstract of paper read before the American Institute of Electrical Engineers, July 26—28th, 1897.

Table XXI.—*Cost per Horse-Power Hour, from Emery's Tables. 7,300 Hours Run.*

Style of engine.	Operating expenses.	Fixed charges.	Total cost.
A	$ 00845	$·00122	$·00967
B	·00741	·00123	·00864
C	·00695	·00110	·00805
D	·00652	·00121	·00773
E	·00610	·00101	·00711
F	·00551	·00107	·00658
G	·00568	·00103	·00671
H	·00508	·00109	·00617
I	·00502	·00110	·00612
J	·00466	·00123	·00589
K	·00445	·00131	·00576
L	·00414	·00129	·00543

Comparisons.

Of modern investigations of the cost of power, none stand higher than those of Dr. C. E. Emery in a paper before the American Institute of Electrical Engineers, March 21st, 1893. I have, therefore, thought it well to include here such parts of the tables as will afford a chance for comparison with the work of the writer and that of others. The investigation by Dr. Emery in this particular case was confined to the large unit of 500 net H.P. and its application must be limited to that amount as any departure will be found to vary the results.

As Dr. Emery's computations are made on net power and with coal at 2,240 lbs. per ton, it has been necessary to reduce his figures to indicated horse-power and coal at 2,000 lbs. per ton, the results being found in Tables XVIII. and XIX. following. Where necessary to bring the items of expense under the same heads, changes have been made in his tables so that direct comparison of items may be made.

Table XVIII. shows itemised costs or 10 hour power per annum and in Tables XX. and XXI. the totals have been reduced to cost per hour per horse-power in order to conform with the argument of the writer that the only correct safe statement is cost per hour and not per annum.

Table XXX.—*Comparison of Cost of Power per annum. By Various Types of Engines. Coal at* $3.00 *per* 2,000 *lbs.*

Type of engine and number of plant.	Power developed.	Cost per H.P. per annum.			
		Operating expenses.	Fixed charge.	3,080 hours.	8,750 hours.
Slow speed non-condensing 1	296	$71.92	$ .81	...	$79.73
" " " 3	59	117.55	33 82	...	151 37
" " " 5	22	88.24	17.80	$106.04	...
" " " 8	129	21.31	9.41	30.72	...
" " " 16	187	18.20	4.47	22.67	...
" " " 12	173	85 90	8.63	94.53	...
" " " Emery ... ... B	556	23.66	8.95	32.61	...
" " " " ... ... B	556	64.91	8.96	...	73 87
" " " Main ... ... XXVIII.	1,000	19.37	6.49	25 86	...
High speed non-condensing 14	21	157.86	28.42	...	186.28
" " " 4	12	175.13	25.40	200.53	...
" " " 15	33	25.38	5.83	31.21	...
" " " 13	53	44.54	19.51	64.05	...
" " " Emery *Eng. Mag.*	10	73.15	6.00	79.16	...
" " " " " "	75	36.50	6 50	43.00	...
" " " " " "	542	26.84	8.62	35.46	...
" " " " " "	542	74.02	8.82	...	82.64
Combination, slow comp. cond. high-speed non-cond. 6	70	137.79	20.76	...	158.55
Combination, slow speed comp. cond. and dbl. cond. ... ... } 19	2,422	14.17	6.73	20.90	...
} 20	1,910	16.33	6.63	22.96	...
Compound high speed non-cond. Emery C	542	22.11	8.01	30.12	...
" " " " " C	542	60.88	8.02	...	68.90
Compound high speed condensing. Emery... ... G	542	18.03	7.57	25.60	...
" " " " " ... ... G	542	49.76	7.56	...	57.32
Triple comp. high speed non-cond. Emery... ... D	542	20.73	8.81	29.57	...
" " " " " " ... ... D	542	57.12	8.80	...	65.92
Triple comp. high speed condensing. Emery. ... I	542	15.93	8.02	24.00	...
" " " " " " ... I	542	43.98	8.02	...	52.00
Slow speed condensing... 2	211	68.87	7.83	...	76.75
" " " Emery ... ... F	556	17.53	7.81	25.34	...
" " " " ... ... F	556	48.27	7.81	...	56.08
" " " " Main ... ... XXVIII.	1,000	16.82	6.36	23.18	...
High speed condensing. Emery ... ... E	542	19.33	7.36	26.75	...
" " " " ... ... E	542	53.44	7.36	...	60.80
" " " " *Eng. Mag.*...	150	26.65	6.00	32.65	...
Slow speed compound condensing 7	1,346	27.75	9.42	37.17	...
" " " " 18	926	13.77	8.77	22.54	...
" " " " 21	1,279	12.75	6.23	18.98	...
" " " " 22	1,011	16.08	7.74	23 82	...
" " " " Emery ... ... H	556	16.18	7.93	24.11	...
" " " " " ... ... H	556	44.50	7.94	...	52.44
" " " " " *Eng. Mag.* ...	250	19.96	6.40	26.36	...
" " " " Webber ... XXIII.	1,050	13.31	6.62	19.93	...
" " " " " ... XXIV.	650	15.68	6.78	22.46	...
" " " " Hale ... XXV.	...	10.75	6.21	16.96	...
" " " " Main ... XXVIII.	1,000	13.40	6.36	19.76	...
Slow speed triple comp. condensing 17	1,175	9.73	5.50	15.29	...
" " " " " Emery... ... J	556	14.82	8.93	23.75	...
" " " " " " ... ... J	556	40 82	8.95	...	49.77
" " " " " " L	556	13 14	9.43	22.57	...
" " " " " " L	556	36.27	9.42	...	45.69
" " " " " " *Eng. Mag.* ...	500	15.19	7.20	22.39	...
Water works pumps. Compound cond. 9	1,352	39.86	29.41	...	69.27
" " " " " 10	37	165.30	96.70	...	261.00
" " " " " 11	42	100.65	63.20	...	163.85
" " " triple " " ... XXVI.	560	47.30	11.64	...	58.94

KEY TO TABLES XVIII., XIX., XX. AND XXI.

Style of engine.

A. Simple high speed non-condensing.
B. Simple low speed non-condensing.
C. Compound high speed non-condensing.
D. Special triple compound high speed non-condensing.
E. Simple high speed condensing.
F. Simple low speed condensing.
G. Compound high speed condensing.
H. Compound low speed condensing.
I. Special triple compound high speed condensing.
J. Triple compound low speed condensing.
K. Triple compound low speed condensing.
L. Ditto, for probable maximum results.

TABLE XXIX.—*Comparison of Different Estimates. Large Compound Condensing Engines.*

	Cost per H.P. per hour.
Emery, A.I.E.E., for 3,080 hours, Table XX.	$·00784
Emery, A.I.E.E., for 7,090 hours, Table XXI.	·00617
Emery, *Eng. Magazine*, 3,080 hours	·00856
Webber, 650 H.P., 3,080 hours, Table XXIV.	·00720
Webber, 1,050 H.P., 3,080 hours, Table XXIII.	·00646
Hale, 2,985 hours, Table XXV.	·00557
Main, 3,080 hours, Table XXVIII.	·00637
Foster, average, 3,080 hours, Table XV. ...	·00824
Average of all	$·00705

CONCLUSIONS.

The writer has attempted in various ways to group the foregoing tables for comparison with each other, but gave up the attempt as hopeless, with the exception of the class of large compound condensing engines used so generally in the large mills of the East; Table XXIX. shows the comparison of costs per hour as developed in the various tables in this class of engine, and although, as previously stated by the writer, the average is hardly to be depended on for use in careful estimates, an average has been computed of the costs by different estimaters and is seen to be $.00705 per horse-power per hour. The especial point the writer desires to bring out, is the widely varying costs here shown; take, for instance, Mr. Hale's of $·00557 as compared with Dr. Emery's of $·00856 or for the writer's of $·00824, the last two are seen to exceed the first by about 50 per cent., a variation which the writer argues does not permit of stating average costs for general use. And, finally, in order that the report may be of more practical value, the results have in Table XXX. been assembled and reduced to cost per horse-power per annum, for 10 hours per day for 308 days, and for 24 hours per day for 365 days.

The first column gives the type of engines, with the number of the plant from the tables; next the amount of power developed, as showing the size of the plant; then operating and fixed expense; and in the last two columns, the total cost per annum for 3,080 hours and 8,760 hours.

This table allows a direct comparison of different plants and different authorities.

THE ELECTRICAL CONDUCTIVITY OF ALUMINIUM.

DATA which have been from time to time published respecting the electrical conductivity of aluminium, have been characterised by considerable discrepancies. These, no doubt, have been due largely to the use of impure material. It is only quite recently that metal containing as much as 99 per cent. of aluminium has been available. Another reason for the discrepancies is doubtless associated with the practice of referring the conductivity to copper or silver standards without indicating the chemical or physical conditions. Imperfect methods of measurement are also, no doubt, to some extent responsible, and finally there has been a lack of an accurate standard of absolute resistance. Bearing all this in mind, J. W. Richards and J. A. Thomson have carried out a series of experiments with the object of obtaining more accurate data for the electrical conductivity of aluminium, paying special attention to the employment of more efficient apparatus than have hitherto been used. Their results are published in the *Journal* of the Franklin Institute, 1897, No. 143, pages 195 to 199.

The results are expressed in absolute measurement. A certified standard resistance coil of 1 international ohm, with a possible error of 0·02 per cent., was used.

The Carey-Foster method of comparison was adopted. The metal in the form of wire (50 feet lengths, the diameter measured by micrometer, checked by weighing and specific gravity), was wound on wooden bobbins, immersed in an oil bath, temperature of which was carefully noted. The standard coil was immersed in water and temperature of room kept constant. The bridge wire was carefully calibrated, and a reflecting galvanometer employed.

Two separate wires were used of the first specimen, and the results only differed by one hundredth per cent. from each other.

Analysis.						Resistance at 0° C. of a wire 1 metre long by 1 mm. diameter in ohms.	Specific resistance at 0° C., *i.e.*, resistance of 1 c.c. in absolute (C.G.S.) units of resistance.	
Aluminium	Iron	Copper	Silicon	Sodium	Zinc	Hard	Hard	Annealed
90·66	0·10	0·00	0 16	0·003	...	0·031245	2,453 7	2,432·2
99·58	0 25	0 00	0·16	0 052	...	0 03290	2,584·0	2 535 0
98·77	0·20	0·57	0 45	0 012	...	0·03627	2,848 0	...
97·16	0 25	2·26	0 30	0 032	...	0·03590	2,819 6	...
94·39	0·25	3·07	0 24	0 052	1 50	0 03583	3,011 4	2,984 7

The authors show, after comparing their figures with those of previous experimenters, that when the impurities are taken into account, the results are fairly in agreement.

McGee determined, in 1890, the conductivity of aluminium of 98·52 per cent. purity to be 54·8 per cent. that of copper, when annealed.

The authors were led to the conclusion that the conductivity of hard-drawn commercial aluminium was strongly affected by impurities, being approximately:—

	(Copper = 100.)
98·5 per cent. of aluminium	55·0
99·0 " "	59·0
99·5 " "	61·0
99·75 " "	63·0 to 64·0
100·00 " " probably ...	66·0 to 67·0

Annealed wire was found to have a conductivity very nearly 1 per cent. greater than unannealed.

It is to be hoped that these results will be found useful, for they are certainly more to be relied upon than those which have hitherto been available.

THE PRECISION OF ELECTRICAL ENGINEERING.*

BY FRANCIS B. CROCKER.

(*Continued from page* 373.)

The facility and accuracy of electrical measurements contributes greatly to the precision of electrical engineering. Volts and amperes can be easily, quickly and accurately measured by means of convenient portable instruments. The product of these volts and amperes gives the watts or power, which is the most important quantity.

If desired, a single instrument—the wattmeter—can be used to combine the two quantities. Electrical resistance can also be measured easily and quickly, and with still greater accuracy. Even the less common electrical quantities, such as capacity and inductance, can be measured without much difficulty, and with reasonable exactness. The magnetic quantities are also quite easily and correctly determined. As already stated, the most doubtful factors in electrical engineering are the mechanical ones.

The enormous range in electrical engineering is still another proof of its precision. The same laws and principles which apply to the almost infinitesimal galvanometer current, are equally applicable to the current from an electric light station. The former may be only a hundred billionth of an ampere, and the latter reaches 10,000 amperes, which is a thousand million million (10^{15}) times greater.

An even greater ratio than this represents the range of resistance measurements. In the case of large copper bars, a determination to within ·000001 ohm is often required, and for insulation testing 10,000 megohms is not an un-

* Inaugural Address of the President at the 14th general meeting of the American Institute of Electrical Engineers, Eliot, Me., July 26th, 1897.

usually high figure. This gives a range of measurement of ten thousand million million (10^{16}).

An electrical instrument, the bolometer of Prof. Langley, is used to measure the heat received from the fixed stars, and electricity is also the agent selected when 100,000 horse-power are to be distributed from Niagara. Instead of saying that electricity is selected for these extreme uses, it would be more correct to state that it must be employed, just as it is the only means of transmitting speech 1,000 miles, or performing the many other miracles of which it alone is capable.

The directness and high efficiency with which electrical energy can be converted into other forms is another fact which gives exactness to our work. It can be transformed into heat, light, magnetic, mechanical or chemical energy, by the simplest means, and conversely, the latter forms, with the possible exception of light, can be readily changed into electrical energy. In most cases the conversion is almost perfect, the efficiency of an electric motor or dynamo being usually over 90 per cent., and often 93 or 94 per cent. The chemical energy in a storage battery represents nearly 90 per cent. of the watt-hours applied to it, assuming the losses in charging and discharging to be about equal. The storage of magnetic energy may be effected at an even higher efficiency of 97 or 98 per cent., and the conversion of electrical energy into heat is complete, the efficiency of an electric stove actually reaching the ideal figure of 100 per cent. The production of light cannot be accomplished so economically, nevertheless the arc lamp has a far higher efficiency than any other source of artificial light, although it is usually stated to be only 8 or 10 per cent. It is also more than probable that the long sought for high efficiency lamp will be an electric one when it is finally invented. This facility and economy of transformation puts electricity directly in touch with the other sciences and their applications, avoiding the chances for error which round-about processes necessarily involve. None of the other forms of energy possesses anything like the same convertibility. The one serious difficulty in connection with electricity is the fact that its generation requires a boiler, engine and dynamo, bringing in heat and mechanical power as steps in the process. If this complication could be avoided, and electrical energy produced directly from the chemical energy of the coal, the only limitation would be removed. This has already been done in an experimental way, and by the substitution of water-power for steam, one piece of apparatus and one form of energy are eliminated; but the complete independence of electrical engineering, and the realisation of all of its possibilities will be secured when the direct conversion of fuel energy into electrical energy is accomplished practically.

It has been shown that there are no less than eight substantial grounds upon which the precision of electrical engineering is based. The consideration of these has incidentally brought out several concrete examples, but it will be well to cite a few other special instances which demonstrate electrical exactness.

The one which first claims our attention not only on account of its historical precedence, but also from its wonder-compelling results, is the locating of faults in ocean cables. In this connection, I quote from information kindly furnished me by one of the vice-presidents of the Institute, Mr. A. E. Kennelly, who has had a long and successful experience in this branch of the profession. He states that: "In the case of cable coiled in a tank and which has been taken into the taken into the tank over a measuring drum without being subjected to any considerable tension, the precision with which a fault in the gutta-percha can be located is sometimes very considerable. I have known one or two cases in which a fault has occurred in a length of, say, 30 miles of cable immersed in water and maintained at practically one temperature in the tank, and in which, by means of the Varley loop test repeated many times and under various conditions to eliminate constant errors, the electrical position of the fault has been determined to within a probable error, representing about 20 feet of length. On turning the cable over from one tank to another by a 7-foot drum on which the cable makes three turns, and cutting the cable when the computed distance has been run over, the fault has been found on the drum; that is, in the 60 feet or so of cable then lying on the drum."

"As regards the location of faults in submarine cables on the ocean bed, the precision depends upon a variety of circumstances, and in general is necessarily much lower than in the case of a cable coiled in a tank. The average error in practice, or the difference between the true electrical and computed positions, is perhaps about 15 ohms, or about 1½ miles of cable having a common resistance of 10 ohms per mile. Under favourable circumstances a complete break in a cable developing a fair extent of surface exposure to the sea water at the end of the copper conductor, the electrical position can be determined within 5 ohms in a total conductor resistance of 1,000 ohms. In the case of a fault in the insulator, sufficiently serious to interfere with signalling, specially favourable cases will occur in which the electrical position of the fault can be determined to within 1 ohm when a loop test is obtainable, and when the total conductor resistance of the loop does not exceed 3,000 ohms." "I have known a case of total loss of continuity in the conductor, accompanied by perfect insulation. It occurred in lifting a cable for repairs, and was within half a mile of the ship. A measurement of electrostatic capacity enabled the distance to be determined within a few yards." Other cases are given by Mr. Kennelly, and many may be found in various works and journals, but these are sufficient to show the astonishing results that are possible, as well as those that are obtained in regular practice.

The methods employed in locating faults in underground conductors are quite similar to those used for submarine cables, but the results are less striking and important. Mr. William Maver, jun., who is an authority on this subject, cites a case in which the calculated position of a fault was 2,343 feet from the testing end of an underground cable 4,200 feet long. The defect was found at the exact point indicated. The alternative would have been the tearing up of the street and cutting through a heavy iron pipe until the fault was found, as the conduit was not provided with manholes. One way to locate a ground connection, which illustrates the simplicity and certainty of electrical testing, consists in sending a current through the conductor to the ground through the fault in the insulation. A compass carried along over the cable will indicate by its deflection or non-deflection when the fault is reached. The facility of overcoming distances and obstacles impassable to other agencies is characteristic of electricity and magnetism.

The writer has had occasion to test the resistance and position of faults ("grounds") on a very large system of underground conductors for electric lighting. Although the problem was complicated by the fact that it was a three-wire system which extended several miles, it was found possible to determine the insulation resistance of each of the three conductors. The position of a "ground" is shown by the potential difference between the conductor and the earth, being a minimum at that point. For example, if a ground connection exists on the positive wire and a considerable current flows through it into the earth, the potential of the earth at that point will be raised above its normal value. The potential difference existing between the wire and the earth is actually less near the ground connection. This may be measured from the station by using the "pressure wires" ordinarily laid with the feeders and special wires which connect to the ground at various points of the system.

The paper on "The Alternating Current Induction Motor," presented by Vice-President Charles P. Steinmetz at this meeting of the Institute, affords an excellent example of the marvellous precision of electrical engineering. In figs. 1 and 2 two curves are shown which give the efficiency, speed, power factor and other characteristics of a three-phase induction motor under various conditions. These curves were all predetermined by calculation. In the same figures the results obtained by actual test are also marked by small crosses. The agreement in all cases is so close, that curves plotted from the actual results of tests would practically coincide with those predicted by calculation. This is all the more remarkable when it is remembered that the three-phase motor is one of the newest of electrical machines, and is a difficult problem from a theoretical standpoint. It has long been possible in designing direct current machinery to predetermine the results with almost as great accuracy as that shown in the curves of Mr. Steinmetz; but, of course, that is a much older problem. Nevertheless, the predetermination of results in direct current machinery is fully as difficult as in the case of alternating current apparatus, because per-

meability is the most doubtful factor in such calculations, and is especially so at the high flux densities used in the former. It is to be observed, however, that any error in the permeability data can be corrected by increasing or decreasing the ampere-turns on the field magnet. This is easily accomplished by providing 5 or 10 per cent. greater E.M.F. than the calculations require, which may be reduced, if necessary, by the introduction of resistance. Since the energy used for the field is a very small percentage of the total amount, it may be considerably varied without materially affecting the other factors in the machine. Sparking at the commutator brushes is an additional and by no means simple question which confronts the designer of direct current apparatus. I remember, however, being informed by Mr. Gano S. Dunn several years ago that he had found by experience in many cases that the efficiency of a direct current dynamo or motor can be predetermined from the drawings before the machine is built, within a fraction of 1 per cent.; in fact, he relied more upon his calculations than upon an actual test of the completed machine, even when performed by skilled men. In one case the calculated efficiency was 93 per cent., and the result obtained by test was 92·7 per cent., and in another case the total flux was found to be 1·38 per cent. greater than the computed value. This agreement is somewhat closer than is found in every day practice, but is not accidental, and can usually be approximated by careful work.

(*To be concluded.*)

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS.—1897.

[*Compiled expressly for this journal by* W. P. Thompson & Co., *Electrical Patent Agents, 322, High Holborn, London, W.C., to whom all inquiries should be addressed.*]

20,444. "Improvements in and relating to telephones." C. Junge. (C. Kraft, C. Huber and I. J. Exner, Roumania.) Dated September 6th. (*Complete.*)

20,449. "Improvements in current conducting rails for electric railway systems." L. E. Walkins and G. M. Jewett. Dated September 6th.

20,455. "An electric igniter for internal combustion engines." P. Jensen. (C. White and A. White, United States.) Dated December 6th.

20,486. "Improvements in and connected with the electro-deposition of copper and other metals on rotary cathodes." W. E. Heys. (The Electrical Copper Company, Limited, France.) Dated September 7th. (*Complete.*)

20,493. "Improvements in and connected with the transmission of energy by alternating currents." C. H. Bradley. Dated September 7th. (*Complete.*)

20,496. "Improvements in surface contact electric railway systems and in apparatus for use therewith." The British Thomson-Houston Co. (W. P. Potter, United States.) Dated September 7th. (*Complete.*)

20,497. "Improvements in and relating to surface contact electric railway systems." The British Thomson-Houston Co. (W. P. Potter, United States.) Dated September 7th. (*Complete.*)

20,498. "Improvements in surface contact electric railways." The British Thomson-Houston Co., Ltd. (W. B. Potter, United States.) Dated September 7th. (*Complete.*)

20,499. "Improvements in and relating to closed conduit or surface contact electric railways." The British Thomson-Houston Co., Ltd. (W. B. Potter, United States.) Dated September 7th. (*Complete.*)

20,500. "Improvements in and relating to surface contact electric railways." The British Thomson-Houston Co., Ltd. (L. H. Parker, United States.) Dated September 7th. (*Complete.*)

20,501. "Improvements in and relating to surface contact or closed conduit electric railway." The British Thomson-Houston Co., Ltd. (W. B. Potter, United States.) Dated September 7th. (*Complete.*)

20,502. "Improvements in and connected with surface contact railway systems and in apparatus for use therewith." The British Thomson-Houston Co., Ltd. (W. B. Potter, United States.) Dated September 7th. (*Complete.*)

20,503. "Improvements in surface contact or closed conduit electric railway systems." The British Thomson-Houston Co., Ltd. (W. B. Potter, United States.) Dated September 7th. (*Complete.*)

20,521. "Improvements in electrical signalling apparatus and circuits." E. H. Owen, C. N. Williams and F. H. Donaldson. Dated September 7th. (*Complete.*)

20,522. "Improvements in annunciator systems." E. H. Owen, C. N. Williams and F. H. Donaldson. Dated September 7th. (*Complete.*)

20,583. "An improvement in electric arc lamps." J. Brockie. Dated September 7th.

20,591. "Improvements in electric tramway and electric transmission of power systems." C. W. G. Little. Dated September 7th.

20,596. "Improvements in or connected with anodes for apparatus for the electro-deposition of metals." A. F. Harris. Dated September 8th.

20,666. "Improvements in dynamo electric machines and motors." S. G. Brown. Dated September 8th.

20,669. "Improvements in or connected with automatic brakes for electrically driven machines." A. B. Blackburn and W. L. Spence. Dated September 8th.

20,703. "Improved metallic diaphragm for electrolysis." B. E. F. Rhodin. Dated September 9th.

20,732. "Improvements in or relating to electric signalling apparatus for railways." G. F. Gascoyne. Dated September 9th.

20,781. "Improvements in the generation and distribution of electricity by means of alternating currents and appliances connected therewith." L. B. Atkinson. Dated September 9th.

20,831. "Improvements in conduits applicable for wires for conveying electricity." J. J. Bate. Dated September 10th.

20,834. "Improvements in arc lamps." J. D. F. Andrews. Dated September 10th.

20,845. "Improvements in accumulators or secondary batteries and in means for transporting the same." A. Muller. Dated September 10th.

20,865. "Improvements in and relating to primary batteries for light, motive power, and like purposes." W. Decker and G. von Struwe. Dated September 10th.

20,833. "Improvements in apparatus for working electric tramways by means of underground cables." C. Anderson. Dated September 11th.

20,913. "Machine for painting electric casing and the like." G. H. Cutting and G. Cutting. Dated September 11th. (*Complete.*)

20,914. "Improvements in coin-freed electricity meters." F. C. Raphael. Dated September 11th.

20,919. "Improvements in electric fire alarm system." J. L. Walker and G. B. Walker. Dated September 11th.

20,923. "Improvements in electric heaters." E. Ethel. Dated September 11th.

20,943. "Improvements in the construction of guards or protectors for incandescent electric lamps and other glass or breakable articles." Dated September 11th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

[*Copies of any of these Specifications may be obtained of* Messrs. W. P. Thompson & Co., 322, High Holborn, W.C., *price, post free,* 8½*d.* (*in stamps*).]

1896.

4,709. "An improved method of an electrical apparatus for automatically reducing and cutting off the steam from and thus preventing the 'racing' of marine engines." S. M. Folk and D. S. Ellis. Dated March 2nd, 1896. Plates of copper are fixed at the stem of the vessel, and arranged so that when the propeller is leaving the water the plates of copper are raised, and the area of electrical contact will be lessened or completely broken. The plates are connected by an insulating wire up to a relay, arranged to complete a circuit through an electro-magnet or solenoid whenever the circuit through the plates is broken; the magnet is arranged to operate either upon the eduction or throttle valve of the main engines, either directly or indirectly, and preferably through the agency of a small auxiliary engine connected on to the eduction valve and slide valve link of the main engines. 2 claims.

4,761. "New or improved device for facilitating the fixing, adjustment and removal of electric lamps or incandescent lamps." F. H. Coulson. Dated March 3rd, 1896. Relates to an improved device for fixing electric incandescent lamps in position without the aid of a ladder. The device consists of a number of springs fixed to a common base piece, and arranged so that a lamp placed between them will be held sufficiently firm to permit of its being attached to or detached from, or adjusted in the ordinary lamp-holder by suitable manipulation of the handle. 3 claims.

5,616. "Improved electrolytic processes and apparatus." A. E. Peyrusson. Dated March 12th, 1896. Relates to an improvement in electrolysis, which consists essentially in the employment of helical electrodes, whereby a prolonged circuit is imparted to the electrolyte in circulation through the coils of the helix whilst undergoing electrolysis. 3 claims.

5,673. "Improvements in apparatus for refining metals by electrolysis." A. S. Elmore. (J. O. S. Elmore.) Dated March 13th, 1896. Relates to apparatus for purifying metals by electrolysis, comprising a series of non-conducting frames and sheets of lead or other suitable metals carrying plates of the crude metal to be refined, these frames and sheets being piled over one another and clamped firmly together, the lowest and uppermost sheets connected respectively to the terminals of a source of electricity, and the sheets having holes through them alternately arranged for passage of electrolyte liquid in zig-zag course between each plate and the sheet above it. 3 claims.